Chapter 3

AFFECTED ENVIRONMENT / ENVIRONMENTAL CONSEQUENCES

Introduction

This chapter offers an overview, by resource program, of the affected environment and the differing environmental effects likely to result from implementation of an alternative. The affected environment includes the existing physical, biological, and socioeconomic components that may be changed by implementation of an alternative.

An analysis of the environmental effects for both the short and long-term, particularly as they relate to the Significant Issues, provides the basis for comparing alternatives. Direct and indirect effects as well as cumulative effects are components of this comparison.

While not specifically identified in this chapter, irreversible and irretrievable commitments of resources are factors in any analysis of environmental effects. Such commitments are usually made at the project level rather than the programmatic level of a Forest Plan.

Irreversible commitments are decisions affecting non-renewable resources such as soils, minerals, and heritage remains. These commitments are considered irreversible because the resource has been destroyed or removed or has deteriorated to the point that renewal can occur only over a very extended period or at great expense.

Irretrievable commitments represent resource uses or opportunities that are forgone or cannot be realized during the planning period. While these decisions are reversible, the opportunities forgone are irretrievable. An example is the application of Standards that do not allow camping where camping might have been allowed. While the decision not to allow camping can be reversed, the opportunities to camp during the period when it was not permitted are irretrievable.

Physical Elements

AIR QUALITY

Affected Environment

In addition to protecting the air, land, and water resources under their jurisdiction from the impacts of air pollution produced outside of federal lands (Clean Air Act 1990), statutes and regulations also require federal land managers to protect air, land, and water from the effects of air pollutants originating from within federal lands (Clean Air Act 1990, Organic Act 1977, Wilderness Act 1997). Activities within the Daniel Boone National Forest such as prescribed burning, road construction/maintenance, mineral development, recreational use, and timber harvesting all have an impact on the air quality of National Forest System land. The Forest Service must minimize the impact of management activities on natural resources, including the Forest's contribution to general air pollution. To fulfill this responsibility, the DBNF must understand the impacts of pollution originating on National Forest System land as well as the impacts of pollution from sources outside the Forest.

The Daniel Boone National Forest is located in an area of increasing population growth and the associated demand for electricity and transportation (SAMI 2002). Lying near the industrial heart of the United States, the Forest is surrounded by a high concentration of coal-fired electrical generating facilities, the leading sources of sulfur dioxide (SO_2) and nitrogen oxide (NO_x) emissions. This network of coal-fired electrical power plants includes the generally defined Ohio River valley as well as Tennessee Valley Authority (TVA) sources. In Kentucky alone there are 18 operating coal-fired power plants (EPA 1999), with several more recently permitted by the state. The Paradise coal-fired power plant, located within 150 miles of the Forest, is the largest point source of NO_x emissions and the second largest point source of SO_2 emissions in the nation. The five largest NO_x emitting point sources and five of the ten largest SO_2 sources in the nation are also located within 150 miles of the Forest; all are electric generating plants. In addition, two interstate highways intersect the Forest, adding additional NO_x and volatile organic compounds to the atmosphere.

Nitrogen oxides are an important contributor to the formation of ground-level ozone on hot sunny days (Chameides and Cowling 1995). Ozone affects the human respiratory system as well as vegetation. From 2000 through 2002, ozone concentrations at 2 out of 6 monitors located near the Forest exceeded, the new 8-hour ozone National Ambient Air Quality Standard (NAAQS) (Table 3 - 1). The 8-hour NAAQS is exceeded if the 3-year average of the 4th highest 8-hour concentrations exceed 0.085 parts per million.

Table 3 - 1. Fourth highest maximum 8-hour ozone values, in parts per million, for ozone monitoring sites located near the DBNF.

COUNTY	AIRS No.	2000	2001	2002	3-Year Average
Bell	21-013-0002	**.090**	.077	**.091**	**.086**
Boyd	21-019-0017	**.079**	**.085**	**.102**	**.088**
Carter	21-043-0500	.080	.076	.086	.080
Fayette	21-067-0012	.076	.078	.080	.078
Perry	21-193-0003	.072	.072	.083	.075
Pulaski	21-199-0003	.087	.077	.077	.081

Values in bold print exceed the NAAQS.

Air quality sampling, analysis and reporting is the result of joint effort of the Kentucky Division of Air Quality (KDAQ) and the U.S. Environmental Protection Agency. Data summaries were obtained from Kentucky's DAQ Annual Ambient Air Monitoring Data Reports for 2001.

Ozone exposures measured at these sites have been high enough to retard growth of susceptible plant species and may lower the abundance of ozone-sensitive species on the Forest (SAMI 2002). About 35 percent of nitrogen oxides affecting the Forest originates from electric generating plants (especially during hot summer days when electricity is needed to cool homes and businesses). Another 34 percent comes from highway vehicles. As current air laws, rules, and regulations are fully implemented nitrogen oxide emissions are predicted to decrease 24 percent by 2010, and 37 percent by 2040 in comparison to 1990 emissions (SAMI 2002). These reductions should lower the highest concentrations of ozone, resulting in only minimal effects from ozone on vegetation growth by the year 2040. Further reductions in nitrogen oxide are also anticipated as state and local air pollution control agencies seek ways to attain the new ozone standard in urban areas near the Forest (SAMI 2002). Continued reduction of nitrogen oxide emissions will benefit the health of Forest visitors as well as vegetation.

Sulfur dioxide and nitrogen oxide emissions are transformed in the atmosphere into sulfates and nitrates (from sulfur dioxide and nitrogen oxides), which contribute to acid deposition and regional haze. Approximately 80 percent of the sulfur dioxide emissions affecting the Forest are released from coal-fired power plants. Power plants to the west and southwest of the Forest most likely influence the acidity and sulfate concentration of rainfall on the Forest (SAMI 2002). Monitoring data from eastern Kentucky suggests that the Forest lies in an area of moderately high sulfate and nitrate deposition for the United States. This level of deposition can be detrimental to aquatic and soil resources in ecosystems not adequately buffered. Most of the Forest's soils and geology have sufficient buffering capacity and acidification is not evident. However, there are limited areas of the Forest, usually on ridges, that appear to be more sensitive to acidification (Barton et al. 2002). Aquatic ecosystems on the Forest show no signs of acidification from atmospheric deposition, again due to adequate buffering. The same pollutants that cause acid deposition also affect visibility.

Regional haze and reduced visibility is caused primarily by sulfates emitted by coal-fired power plants. The estimated natural background visibility for the eastern United States is 93+28 miles (NAPAP 1991). However, there has been a significant reduction in how far an observer can see into the distance as well as the clarity of that view. Visibility monitoring data from Mammoth Cave National Park provides the best estimate of haze conditions on the forest. The clearest days have the lowest fine particle mass (4.23 microgram per cubic meter [ug/m3]), and estimated visibility is 57

miles (using the annual average relative humidity of 84%). On the highest mass (20.67 ug/m3) days the visibility is reduced significantly to 14 miles. These days are most likely to occur from May through September (IMPROVE 2002), a time of high visitation by the public. Secondary fine particles ($PM_{2.5}$, i.e., fine particulate matter less than 2.5 microns in diameter) are primarily responsible for visibility impairment, with sulfates the most significant of these fine particles. On low mass days sulfates comprise 48 percent of the total mass, while on the highest mass days, sulfates comprise 70 percent of the total (IMPROVE 2002).

Sulfur dioxide is expected to decrease 22 percent by 2010 and at least 60 percent by the year 2040 in the Southern Appalachians (SAMI 2002). Further reductions by coal-fired power plants in North Carolina (as a result of recent state legislation) and the Tennessee Valley Authority may benefit visibility and air quality on the southern portion of the Forest.

The fine particles that cause visibility impairment also can be unhealthy for people, because high concentrations aggravate respiratory conditions such as asthma. Fine particles are closely associated with increased hospital admissions and emergency room visits for heart and lung disease, increased respiratory disease and symptoms, decreased lung function, and even premature death (EPA 1997a). Vulnerable groups at greater risk include the elderly, individuals with cardiopulmonary diseases such as asthma, and children. This makes monitoring of fine particle levels important.

Monitoring results for fine particulates include both fine primary particulate (that emitted directly from a source) and secondary particulate (resulting from the transformation of gases in the atmosphere). The U.S. Environmental Protection Agency has established NAAQS for fine particles ($PM_{2.5}$) based on three-year averages of the monitoring data. The $PM_{2.5}$ annual average standard is 15 micrograms per cubic meter (ug/m3). Table 3 - 2 lists results from monitors near the Forest from 2000 through 2002. Results indicate that the annual average $PM_{2.5}$ standard may have been exceeded at the Bell, Boyd and Fayette County monitors. The annual average is also very close to violating the standard at the Madison and Perry County monitors. The $PM_{2.5}$ short-term (24-hour) standard is 65 ug/m3 based on a 3-year average of the annual 98th percentile values. (Note that the short-term concentrations are maximum values, not the 98^{th} percentile). The 24-hour average NAAQS does not appear likely to be exceeded when the data from the closest monitoring sites to the Forest are averaged for three years.

Table 3 - 2. Annual average and 24-hour maximum fine particulate concentration (ug/m3) for monitoring sites located near the DBNF.

		2000		2001		2002	
County	AIRS No.	Annual Average	24-hour Maximum	Annual Average	24-hour Maximum	Annual Average	24-hour Maximum
Bell	21-013-0002	**18.1***	41.5	**15.1**	36.8	**14.3**	34.5
Boyd	21-019-0017	**17.2**	37.2	**15.3**	54.4	**15.5**	46.8
Carter	21-043-0500	**15.1**	29.5	12.4	47.3	12.4	39.3
Fayette	21-067-0012	**17.2**	38.6	**15.7**	48.6	**15.9**	56
Fayette	21-067-0014	**17.5**	39.5	**16.2**	49.0	**16.5**	51.9
Laurel	21-125-0004	---	---	---	---	13.0	23.5
Madison	21-151-0003	**15.9**	37.3	13.9	50.6	14.4	49.8
Perry	21-193-0003	**16.8**	34.9	14.3	36.5	13	25.4

*Values in bold print exceed the NAAQS

Air quality sampling, analysis and reporting is the result of joint effort of the Kentucky DAQ and the U.S. Environmental Protection Agency. Data summaries were obtained from Kentucky's DAQ Annual Ambient Air Monitoring Data Report for 2002, and EPA AIRS website, http://www.epa.gov/air/data/index.html. There is only one year of data available for the Laurel County monitor that was installed in 2002.

Based on the 2000-2002 ozone and fine particulate figures, the Lexington metropolitan statistical area (Fayette County monitors) could reach non-attainment for fine particulate. The Huntington metropolitan statistical area (which includes Boyd, Carter and Greenup Counties) and Bell County could reach non-attainment for fine particulate and ozone. Ultimately, the state and the EPA will make non-attainment determinations for fine particles and ozone based on a more recent set of monitoring data. Minimizing prescribed fire emissions to the greatest extent practical during days characterized by existing or predicted high ambient air pollution, therefore, becomes an even higher priority for prescribed fire managers. The $PM_{2.5}$ standard may require even more vigilance in smoke management to protect citizens on and off National Forest System lands from the effects of particulate emissions associated with prescribed fire.

Once an area is cited for non-attainment, a State Implementation Plan is developed in an attempt to bring the area back into attainment. This usually involves placing controls on various sources that contribute to the pollutant of concern. Current emission inventories do not accurately reflect emissions from prescribed burning. Since 70 percent of particulate emissions from prescribed fires are fine particles, and nitrogen oxides and volatile organic compounds are also released, state air regulators will be concerned. The Forest will need to interact closely with the KY Division of Air Quality and the Regional Haze Planning Organizations to ensure that Forest prescribed fire emissions (and perhaps other Forest activities) are accurately considered in State Implementation Plans for PM2.5 and visibility.

Air Quality -- Effects of Prescribed Fire

As an ecological process, prescribed fire is essential in creating and maintaining functional ecosystems and achieving other land use objectives. However, emissions from prescribed fire, as well as from wildland fire, affect air quality. In 1997, the Environmental Protection Agency (EPA) adopted more stringent air quality standards for ozone and $PM_{2.5}$ to protect human health (EPA 1997b). One challenge in using prescribed fire is balancing the public interest objectives of protecting human health and welfare (from air pollution) with sustaining ecological integrity. Recognizing this, the EPA developed an interim air quality policy for wildland and prescribed fires that allows fire to function, as nearly as possible, in its natural role of maintaining healthy ecosystems, but still protects public health and welfare by mitigating the impacts of emissions on air quality and visibility (EPA 1998).

To minimize the negative effects of smoke and associated pollutants on visibility and human health, smoke management plans are a required part of every prescribed fire burn plan. The smoke management plan identifies smoke dispersion characteristics that must be met in the weather forecast for the day of the burn. These characteristics include: the depth of the atmosphere available for smoke mixing (dispersion), transport wind speed and direction, and the probability of air mass stagnation during the day. The Forest also identifies smoke sensitive targets (including non-attainment areas) within the probable smoke impact area and coordinates with them to avoid or mitigate problems. Actual weather conditions and smoke behavior are monitored to make sure they meet the plan. By planning and executing prescribed fires on days that maximize smoke dispersion and avoiding smoke sensitive areas, the negative effects of smoke can be reduced.

Several alternatives propose substantial increases in the use of prescribed fire over current levels. At the same time, some counties within or near the Forest proclamation boundary could well exceed the National Ambient Air Quality Standards for $PM_{2.5}$ and be found in non-attainment (Table 3 - 2). Information sharing and other cooperation between the Forest Service, the Kentucky Division of Air Quality, and others will be essential to incorporate Forest Service emissions into the inventories needed to develop future attainment plans. The Forest will also be expected to follow Conformity Determination rules and report any prescribed fire emissions for activities planned in non-attainment areas.

EFFECTS COMMON TO ALL ALTERNATIVES

DIRECT AND INDIRECT EFFECTS

[Note: There were no cumulative effects common to all alternatives.]

Emissions from both prescribed and wildland fires are generated by incomplete combustion and include particulate matter, carbon monoxide, carbon dioxide, nitrogen oxides, and hydrocarbons (Hardy et al. 2001). The single-most important emission is fine particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), which limits visibility and aggravates respiratory conditions in susceptible individuals. Fine particulates ($PM_{2.5}$) make up more than 70 percent of the mass of particulate matter produced by fire. Therefore, $PM_{2.5}$ emissions were used to compare the direct effects of alternatives on air quality. Emission estimates are calculated for the maximum acres planned for treatment using our best estimates of fuel type, amount of fuel consumed, and emission

rates for the types of burns planned. The results are presented in Table 3 - 3. Acres burned in any year, as well as resulting $PM_{2.5}$ emissions, will depend on weather conditions and other factors that must be considered prior to initiating a prescribed fire.

Particulate emissions from prescribed fire are only one of many sources of $PM_{2.5}$ pollution. Other sources of include power plants, various industries, and motor vehicles. For direct and indirect effects analysis, Forestwide $PM_{2.5}$ emissions were estimated for each Alternative and compared to historic prescribed-fire emissions and current primary $PM_{2.5}$ emissions from other sources. The analysis area is comprised of Kentucky counties containing National Forest System lands. The cumulative analysis also includes prescribed fire anticipated on the Big South Fork National River and Recreation Area, where approximately 300 acres per year may be burned (including lands in Kentucky and Tennessee). No other prescribed burning that is anticipated in the analysis area.

The most recent EPA emissions inventory, used to compare prescribed fire emissions to total emissions in the analysis area, estimates primary $PM_{2.5}$ emissions at 10,993 tons per year (EPA 1999). In addition to the fine particulates emitted directly into the atmosphere (primary pollutants), fine particulates can be created from gaseous pollutants that are chemically transformed into particulates in the atmosphere (secondary pollutants). Emission inventories track only primary pollutants; fine particulates from secondary pollution are not included. Because a large amount of $PM_{2.5}$ is secondary pollution, the contribution of prescribed fire emissions to total $PM_{2.5}$ will probably be less than shown in this analysis.

Predicted changes in emissions are based on a regional assessment and are not representative of any one location on the Forest. Estimated emissions would not be evenly distributed across the Forest because treatment areas vary annually. Site-specific analyses of smoke dispersion and downwind fine particulate impacts take place when sites are selected for treatment.

Table 3 - 3. Estimated particulate matter ($PM_{2.5}$) emissions, in tons, resulting from prescribed fires on the DBNF.

			Percent Change from Current Inventory			
	Annual Emissions		Emissions Due to Direct/Indirect Effects		Emissions Due to Cumulative Effects	
ALT.	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
A	761	761	6.9	6.9	7.0	7.0
B-1	143	143	1.3	1.3	1.4	1.4
C	1,159	2,458	10.5	22.4	10.7	22.5
C-1	1,159	2,458	10.5	22.4	10.7	22.5
D	1,159	2,458	10.5	22.4	10.7	22.5
E-1	143	143	1.3	1.3	1.4	1.4

Current $PM_{2.5}$ emission levels were taken from the EPA 1999 emissions inventory available at http://www.epa.gov/air/data/netdb.html

ALTERNATIVE A

DIRECT AND INDIRECT EFFECTS

Alternative A represents a continuation of the prescribed fire program of the 1985 Plan. Prescribed fire would be authorized on a maximum of 15,000 acres annually, producing approximately 761 tons of $PM_{2.5}$ per year. However, the largest program over the last 10 years occurred in 1997 when 12,929 acres were treated. $PM_{2.5}$ emissions that year were estimated at 539 tons. On average, the Forest has treated 5,698 acres annually with prescribed fire since 1992. Estimated $PM_{2.5}$ emissions from this program total 227 tons. The analysis of direct and indirect effects that follows for all alternatives assumes that it is appropriate to compare emissions from alternatives to the average emissions from actual prescribed fire programs over the past 10 years.

CUMULATIVE EFFECTS

Emissions from Alternative A represent approximately seven percent of primary $PM_{2.5}$ emissions in the analysis area. Additional prescribed fire activity anticipated in the analysis area would occur on the Big South Fork National River and Recreation Area, where approximately 300 acres of shrubland or forested land might be burned per year, including lands in Kentucky and Tennessee. Emissions from these burns would contribute an estimated 13 tons annually to $PM_{2.5}$ concentrations. Addition of the Big South Fork emissions to the Alternative increases the prescribed fire contribution to overall $PM_{2.5}$ about one-tenth of one percent. Other land management agencies within the proclamation boundary also plan to burn grasslands, but at a level that would contribute negligibly to emissions.

ALTERNATIVES B-1 AND E-1

DIRECT AND INDIRECT EFFECTS

Since the number of acres proposed for treatment in Alternatives B-1 and E-1 are the same, emissions would be the same. These alternatives propose prescribed fire on 2,377 acres annually, producing approximately 143 tons per year of fine particulates each year.

On average, the Forest has used prescribed fire on 5,698 acres annually since 1992, producing an estimated 227 tons of $PM_{2.5}$ emissions each year. In comparison, acres treated under Alternatives B-1 and E-1 would decrease along with emissions.

CUMULATIVE EFFECTS

Emissions from Alternative B-1 and E-1 would increase primary $PM_{2.5}$ emissions in the analysis area about one percent. Additional prescribed fire activity anticipated in the analysis area would occur on the Big South Fork National River and Recreation Area, where approximately 300 acres per year might be burned, including lands in Kentucky and Tennessee. Emissions from these burns would contribute an estimated 13 tons annually to $PM_{2.5}$ concentrations. Addition of the Big South Fork emissions to the alternatives increases the prescribed fire contribution to overall $PM_{2.5}$ about one-tenth of one percent. Other land management agencies within or near the proclamation boundary also plan to burn grasslands, but at a level that would contribute negligibly to emissions.

ALTERNATIVES C, C-1, AND D

DIRECT EFFECTS

Since the number of acres proposed for treatment in Alternatives C, C-1, and D are the same, emissions would be the same. Alternatives C, C-1, and D would incrementally increase the acres treated over the first 10 years of the planning period from 15,000 to 50,000 acres. Emissions were calculated for the maximum acres that might be treated in the first and last years to provide a range of maximum potential annual emissions over the course of the planning period.

Prescribed fire programs in Alternatives C, C-1, and D would produce the highest levels of $PM_{2.5}$ of all alternatives. Each of these alternatives would produce a maximum of 1,459 to 2,458 tons of $PM_{2.5}$ per year; the lower number representing the earlier years of the planning period, and the larger value the later years.

On average, the Forest has used prescribed fire on 5,698 acres annually since 1992, producing an estimated 227 tons of $PM_{2.5}$ emissions each year. In comparison, acres treated under Alternatives C, C-1 and D would increase and so would emissions. The largest prescribed fire program over the previous 10 years occurred in 1997 when 12,929 acres were treated. $PM_{2.5}$ emissions that year were estimated at 539 tons. Emissions from Alternatives C, C-1 and D could double the 1997 emissions in the early years of the planning period. By the end of the planning period, $PM_{2.5}$ emissions could be five times the 1997 levels.

CUMULATIVE EFFECTS

The larger prescribed fire programs proposed in Alternatives C, C-1, and D would increase primary $PM_{2.5}$ emissions in the analysis area by 10 to 22 percent. Additional prescribed fire activity anticipated in the analysis area would occur on the Big South Fork National River and Recreation Area, where approximately 300 acres per year might be burned (including lands in Kentucky and Tennessee). Emissions from these burns would contribute an estimated 13 tons annually to $PM_{2.5}$ concentrations. Addition of the Big South Fork emissions to the Alternative increases the prescribed fire contribution to overall $PM_{2.5}$ about one-tenth of one percent. Other land management agencies within the proclamation boundary also plan to burn grasslands, but at a level that would contribute negligibly to emissions.

Air Quality – Effects of Oil and Gas Leasing

The Forest Service is assessing the environmental consequences of leasing natural gas exploration and production rights on the Daniel Boone National Forest under a variety of alternatives. The primary criteria pollutant emissions from development of natural gas wells are nitrogen oxides (NO_x) and volatile organic compounds (VOC). In the presence of sunlight, these pollutants combine to form ozone, a regulated pollutant that affects vegetation and human health. There is one ozone monitor in the analysis area, located in Pulaski County, Kentucky. Data from this site suggests the possibility that this county will reach non-attainment for ozone (Table 3 - 1). This analysis seeks to estimate the potential air quality impacts of emissions from the proposed activities.

EFFECTS COMMON TO ALL ALTERNATIVES

DIRECT AND INDIRECT EFFECTS

[Note: There were no cumulative effects common to all alternatives.]

Air quality impacts from development of a natural gas field can be divided into two categories: construction of well sites and well production/operation. While the construction phase is relatively short, the production phase persists as long as the well produces gas.

Construction emissions include the pollutant emissions from well pad development, which involves three separate, sequential activities:

1) Clearing, grading, and construction of the road that connects the existing access road to the well pad site. Construction traffic over unpaved roads as well as tailpipe emissions from construction traffic produce fugitive dust emissions.

2) Rig-up, drilling, and rig-down. These activities consist of bringing equipment and supplies by truck to the well site, drilling a hole to the desired depth, and removing the drilling equipment. Pollutant emissions during this phase include the particulates from traffic on unpaved roads, vehicle tailpipe emissions, and exhaust emissions from drilling engines.

3) Completion and testing involves running pipe into the borehole and flaring small quantities of gas at the surface to evaluate well productivity. Pollutant emissions that occur during completion and testing include road dust from vehicle traffic, vehicle tailpipe emissions, and combustion products from the flaring of natural gas.

Gas produced from leased wells on the Forest would be collected and piped to a compressor station located on private land. The main source of emissions from the production phase would be from fugitive equipment leaks. Lesser emissions come from the heater-separator that is designed to separate liquids from the gas stream and the condensate storage tank that collects the liquids. Heat comes from burning some of the methane produced by the well.

The emission rates for construction and production activities are taken from a Bureau of Land Management report, “Environmental Assessment: Cooper Reservoir Natural Gas Development Project -- Cumulative Air Quality Impact Analysis (USDI BLM 1998, Appendix A). The Cooper Reservoir Project activities are similar to what would occur in gas field development in eastern

Kentucky, which makes it possible to use the pre-calculated emissions for this analysis. Activities are of similar duration, similar equipment, and both projects involve "sweet" gas which does not produce hydrogen sulfide during flaring.

The primary criteria pollutants emitted by producing gas wells include volatile organic compounds and nitrogen oxides (NOx), the primary criteria pollutants emitted during the construction phase. Each alternative has a specified maximum number of wells that could be put into production over the next two decades. The emissions from construction and operation of the "reasonably foreseeable development scenario" on the Forest are calculated and compared between alternatives for the direct and indirect effects analysis. Annual emissions of these pollutants were calculated based on projections of the number of wells developed each year over 20 years. Construction emissions were calculated and included only in the year the well was developed. Production emissions were included in the total emissions calculated for the year the well was constructed and in all years following, for 20 years. It was assumed that all wells developed would produce gas over the remainder of the 20-year analysis period. This would result in increasing emissions over time as incremental development of wells occurred. The range of annual emissions that could be produced over the analysis period is represented by a minimum and maximum value for each alternative shown in Table 3 - 4.

Table 3 - 4. Estimated annual air pollution emissions, in tons, resulting from projected gas well development on the DBNF.

	Direct Effects				Cumulative Effects			
	Annual Volatile Organic Compound Emissions (tons)		Annual Nitrogen Oxide Emissions (tons)		Annual Volatile Organic Compound Emissions (tons)		Annual Nitrogen Oxide Emissions (tons)	
Alt.	Min	Max	Min	Max	Min	Max	Min	Max
A	11	175	12	40	1,023	19,639	1,121	3,879
B-1	0	0	0	0	1,003	19,344	1,100	3,831
C	13	196	14	29	1,031	19,750	1,129	3,898
C-1	13	196	14	29	1,031	19,750	1,129	3,898
D	13	196	14	29	1,031	19,750	1,129	3,898
E-1	19	296	21	43	1,047	19,984	1,147	3,936
Current EPA Emissions Inventory-1999					31,832		41,084	

ALTERNATIVES A, C, C-1, D, AND E-1

DIRECT AND INDIRECT EFFECTS

There is essentially no difference in air pollution emissions between the reasonably foreseeable development scenario for Alternatives A, C, C-1, D, and E-1. Emissions would be similar for these alternatives because the number of wells developed under each would be about the same. Volatile organics and nitrogen oxide emissions are calculated for the number of wells projected for construction and production in each year of the 20-year analysis period. The ranges of annual emissions that could be produced over the 20-year analysis period are represented by a minimum and maximum value for each alternative in Table 3 - 4.

CUMULATIVE EFFECTS

Emissions from private-rights wells on National Forest System lands and gas wells off-Forest are added to the emissions from the "reasonably foreseeable development scenario" to assess "Cumulative Effects." Development of gas wells under the leasing decision is completed by year 15 of the analysis, but the other wells would continue to be developed through all 20 years of the analysis. Projected emissions from all wells that could be developed in the analysis area are displayed in Cumulative Effects columns of Table 3 - 4. The minimum represents year-1 emissions and the maximum represents year-20 emissions. It is clear that emissions from wells developed under the reasonably foreseeable development scenario (Direct Effects), in any of the alternatives, would be only a fraction of those from private-rights wells on the Forest and gas wells off-Forest (Cumulative Effects).

Cumulatively, maximum emissions from all projected development could be about 62 percent of current inventoried VOC emissions. Maximum nitrogen oxide emissions are about 10 percent of the current inventory.

ALTERNATIVE B-1

DIRECT AND INDIRECT EFFECTS

Alternative B-1 calls for no development of federally owned natural gas resources on the Forest. With no new wells drilled or operated, no additional emissions would be generated and existing air quality would not be affected. However, privately owned natural gas resources would remain open to development. Potential emissions from these sources are addressed under Cumulative Effects.

CUMULATIVE EFFECTS

Wells to recover privately owned natural gas resources on the Forest could be drilled and operated. Emissions from such development as well as emissions from wells on private lands within the vicinity of the Forest are presented in Table 3 - 4.

SOIL AND WATER

Affected Environment

Hydrologic Features

Kentucky has over 89,000 miles of perennial rivers and streams (Kentucky Division of Water 1998) of which about 7,400 miles lie within the Daniel Boone National Forest proclamation boundary. With so many perennial watercourses running through the forest area in addition to about 34,600 miles of ephemeral and intermittent streams, providing stream course protection and ensuring water quality is an important task for Forest managers. The DBNF manages between 6 and 10 percent of the watersheds within the Ohio River Basin, including portions of the Licking, Kentucky and Cumberland Rivers (Figure 3 - 1). Collectively, these watersheds cover 10.3 million acres or 40 percent of the state, providing surface and groundwater resources for more than one million people. The following section describes the major features of the segments of these three river systems that flow through the DBNF, including major tributaries and reservoirs as well as rivers with special designations. In the Environmental Consequences section of this chapter, each of the three major basins will be subdivided into 49 watersheds (Figure 3 - 2).

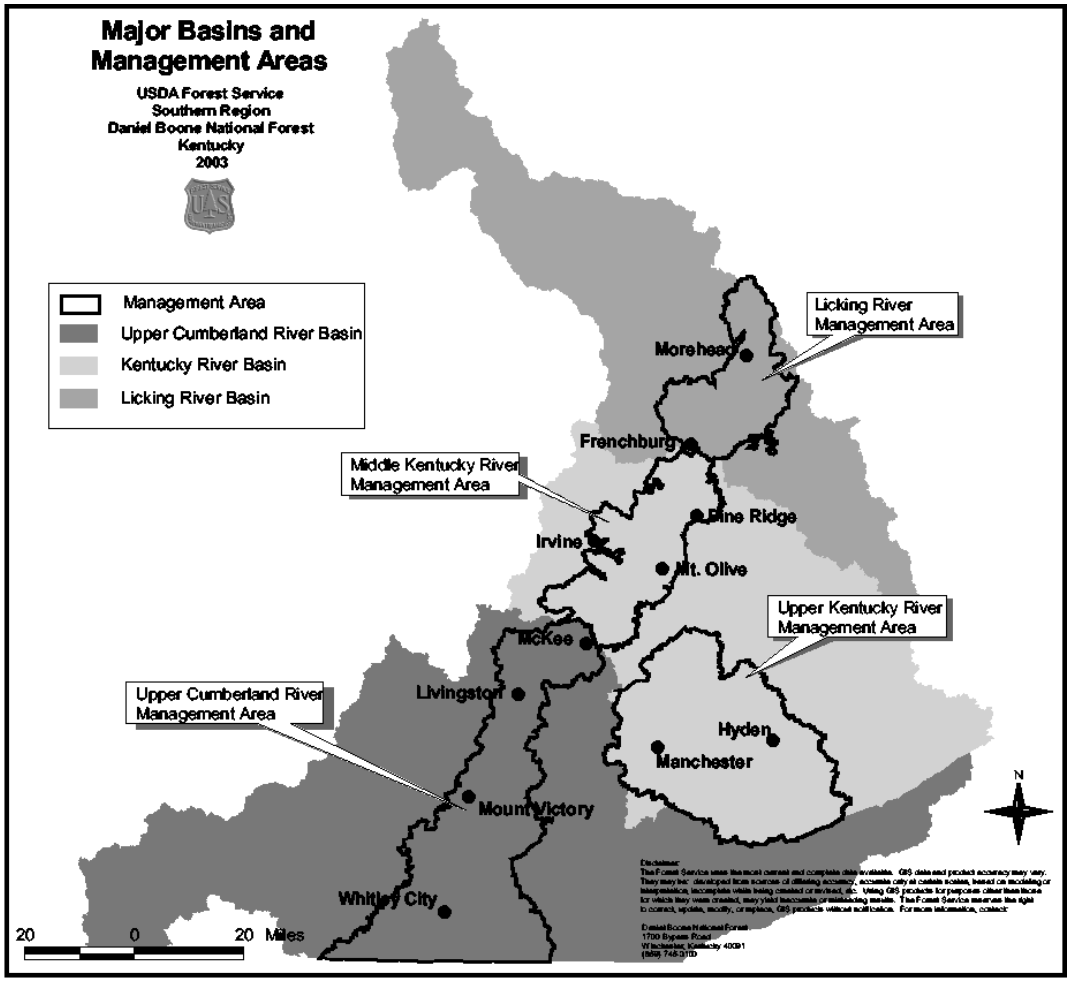

Figure 3 - 1. The relationship between major basins and Management Areas.

Cumberland River System: The headwaters of the Cumberland River flow from the Cumberland Mountains of southeastern Kentucky, an area with the highest elevations in the state. From the confluence of Poor and Clover Forks in Harlan County, the Cumberland River flows 308 miles, generally west and south through a gap in Pine Mountain and across the Cumberland Plateau and Highland Rim before entering Tennessee near the southeastern corner of Monroe County, Kentucky. The river then flows in a broad southward arc in north-central Tennessee, turning northwestward through Nashville and reentering Kentucky in south-central Trigg County. The two segments within the DBNF Proclamation Boundary are the middle segment, which includes drainages from Cumberland Falls downstream to the Kentucky-Tennessee border, and the upper segment, which includes the basin above Cumberland Falls (Burr and Warren 1986). The combination of these two segments, designated as the Upper Cumberland River Management Area, include approximately 50 percent of National Forest System land with the DBNF.

Middle Cumberland River Drainage: Most of the middle Cumberland River drainage lies in the Highland Rim of Kentucky and Tennessee and the Central Basin of Tennessee (Quarterman and Powell 1978), although portions of the basin drain the Cumberland Plateau. The Kentucky portion of this segment encompasses 5,016 square miles, of which roughly 10 percent is National Forest System land. In an upstream direction, major tributaries of the Kentucky portion of the middle basin include the Big South Fork, Rockcastle, and Laurel Rivers. The mainstream is dammed in southwest Russell County to form Lake Cumberland, a 50,230-acre reservoir, which impounds the lower reaches of tributaries upstream to the confluence of Laurel River. Laurel River is impounded above its confluence with the Cumberland River, forming a 6,056-acre reservoir that floods a considerable portion of its tributaries. The area is heavily forested and scenic, containing some of the most pristine waters remaining in the state. Four stream and river segments in the basin have been designated Kentucky Wild Rivers including a 13.3-mile segment of the lower Rockcastle River, a 10.2-mile segment of Little South Fork, an 17.5 mile-segment of Rock Creek, and a 10.1-mile segment of Big South Fork. A portion of the Big South Fork also is part of a National River and Recreation Area managed by the National Park Service. Both Rock Creek and Rockcastle River are being considered for designation as national wild and scenic rivers (USDA Forest Service 1992, 1994a). Streams and rivers of the middle Cumberland River are upland in nature with alternating riffles and pools, incised meanders, narrow flood plains, and rocky substrates. Streams and rivers bordering or heading on the sandstone-capped Southwestern Escarpment and Cumberland Plateau (i.e., Rockcastle, Laurel, and Big South Fork Rivers) have high gradients with low waterfalls, boulder-strewn swift shoals, and deep holes. Creeks and streams draining the Cumberland Plateau immediately below Cumberland Falls also are high gradient, and several have falls near their mouths. These falls and hanging valleys were created by the upstream progression of Cumberland Falls (Burr and Warren 1986).

Upper Cumberland River Drainage: The Upper Cumberland River Drainage includes about 1,977 square miles above Cumberland Falls. The mainstream of the river begins at the confluence of Clover Fork and Poor Fork near Harlan in the southeastern most part of Kentucky. From its headwaters, the Cumberland River drains the Cumberland Mountains to the southeast and the Pine Mountain Overthrust to the northwest. The Cumberland River is joined from the north by Straight Creek before entering the Cumberland Plateau near Pineville. Other major tributaries entering from the north include Stinking, Richland, and

Watts Creeks. Many southern tributaries, including Clear Fork, Jellico, and Marsh creeks, have their headwaters in northern Tennessee. Near the mouth of Marsh Creek, the mainstream abruptly turns north before plunging 55-feet over Cumberland Falls. Cumberland Falls probably originated near Burnside, Kentucky about 45 miles downstream of its present position, and the upstream progression of the falls has left a 400-foot wide gorge through the surrounding Cumberland Plateau. A 14.9-mile section of the Cumberland River (including Cumberland Falls) in McCreary and Whitley Counties is a Kentucky Wild River and has been proposed for National Wild and Scenic River designation. Marsh Creek in McCreary County also has been proposed for federal designation (USDA Forest Service 1992, 1994). The creeks, streams, and rivers of this basin are examples of the most scenic and pristine upland waters in Kentucky. Tributaries draining the Cumberland Mountains and Pine Mountain Overthrust have extremely high gradients and few pools but numerous riffles, waterfalls, and large sandstone substrates. Most Upper Cumberland streams in the DBNF begin on the Cumberland Plateau. Tributaries draining the Cumberland Plateau are similar although they originate at lower elevations than tributaries draining the Cumberland Mountains and the Pine Mountain Overthrust. Extensive reaches of the Cumberland River mainstream and its large tributaries flow over bedrock and contain long boulder- and cobble-strewn shoals and deep, rocky pools. The substrates of the region are sandstone, shale, siltstone, and coal (Burr and Warren 1986).

Licking River System: The Licking River system begins on the Cumberland Plateau in Magoffin County and flows northwestward through the Bluegrass Region for about 310 miles before joining the Ohio River near Covington. The basin encompasses approximately 3,707 square miles, of which six percent is managed by the DBNF. Two major tributaries, the North and South Forks, join the river near Milford and Falmouth. The basin is bounded on the north and northeast by the Ohio River, Kinniconick Creek, Tygarts Creek, and Little Sandy River drainages; on the east by the Big Sandy drainage; and on the south and southwest by the Kentucky River drainage. The Licking River is dammed near Morehead to form Cave Run Lake (8,267 acre), which impounds 38 miles of the main stem, as well as the lower reaches of several tributaries. The creeks, streams, and rivers of the basin are generally upland, having moderate- to high-gradients, well-developed riffles and shoals, rocky substrates, and poor to moderate flood plain development (Burr and Warren 1986). This watershed, within the Proclamation Boundary, has been designated as the Licking River Management Area. Approximately 17 percent of the lands managed by the DBNF are within the Licking River basin or Management Area.

Kentucky River System: The headwaters of the Kentucky River system flow from the rugged mountain area along the Pine Mountain Overthrust on the Cumberland Plateau. The DBNF manages approximately six percent of the 6,966 square mile watershed. From the confluence of the North, Middle, and South Forks near Beattyville, the river flows northwestward 256 miles through the Bluegrass Region before joining the Ohio River near Carrollton. Major tributaries from the mouth upstream include Eagle Creek, Elkhorn Creek, Dix River, Red River, and the North, Middle, and South Forks. A 19.4-mile section of the Red River has been designated a Kentucky Wild River and a National Wild and Scenic River (USDA Forest Service 1992, 1994a). War Fork Creek in Jackson County is proposed for federal designation. Buckhorn Lake (1,230 acres) on the Middle Fork in Leslie and Perry Counties is the only major flood control and recreational reservoir within the Kentucky River system that is within the DBNF proclamation boundary. The streams and rivers of the basin have been characterized as upland; however, many smaller streams in the Bluegrass section

are intermittent, and have hanging valleys up to their confluence with the main stream. Locks and dams that extend along the main stem from near the mouth upstream to Beattyville. The pooling of much of the mainstream and the lower reaches of many tributaries resulted in the loss of most riffle and shallow water habitat (Burr and Warren 1986). The Kentucky River basin within the proclamation boundary has been divided into two Management Areas, the (Middle Kentucky River and Upper Kentucky River). Approximately 12 and 21 percent of the lands managed by the DBNF are within the Middle and Upper Kentucky basins or Management Areas respectively.

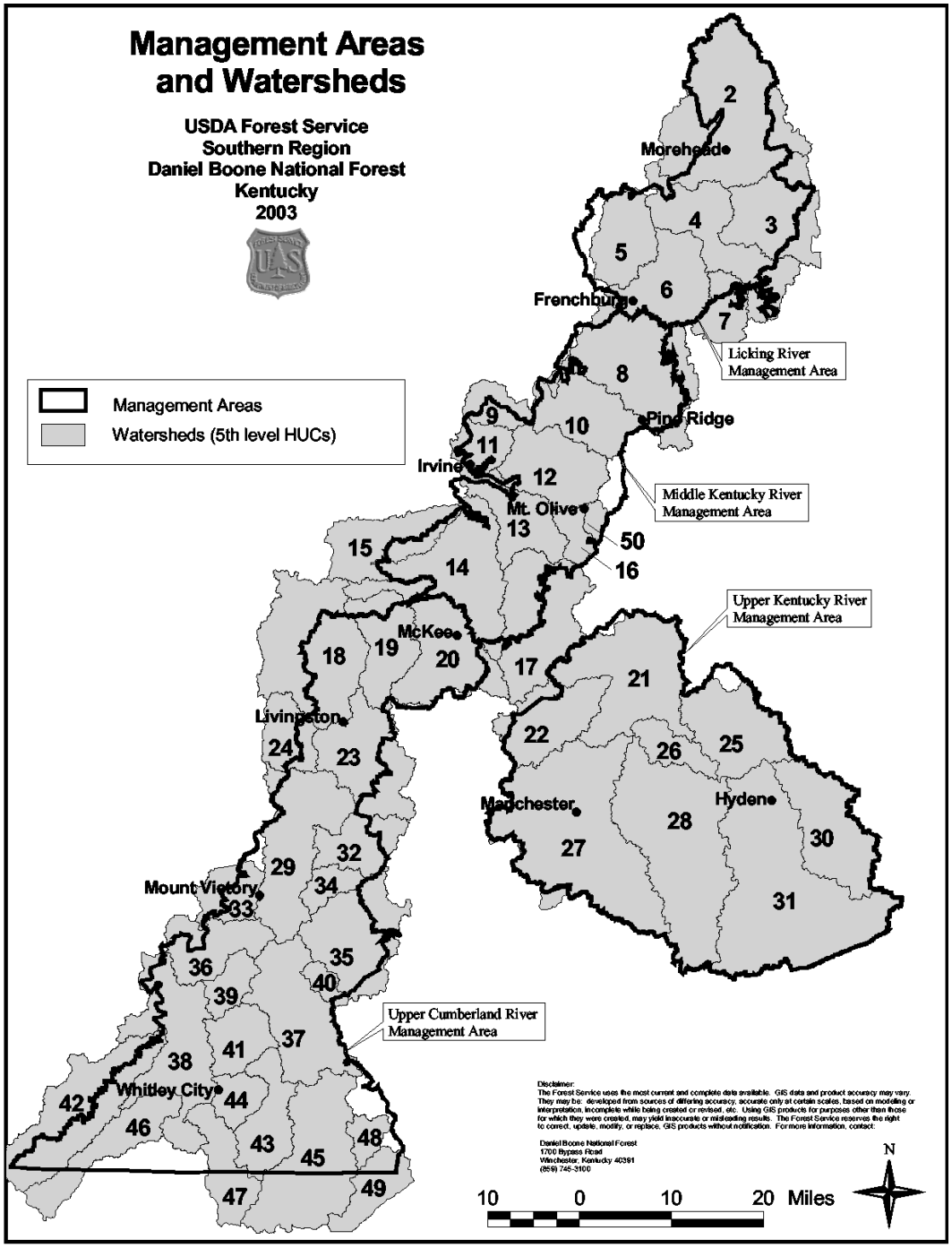

Figure 3 - 2. The relationship between Management Areas and watersheds.

Soils

Currently about 90 different soils have been mapped and classified on the Forest and are included in 280 mapping unit delineations, representing one or more soils. The dominant kinds of soils on the Forest, their location and extent, can be described in such brief and general terms as: deep, fine-loamy and fine-silty soils occurring on alluvial bottoms and terraces, on about four percent of the Forest; moderately deep to deep, fine-loamy, coarse-loamy and loamy-skeletal soils occurring on gently sloping to steep side-slopes and deep, fine-loamy soils in coves, on about 73 percent of the Forest; and moderately deep to deep fine-loamy, fine-silty, fine, and clayey textured residual soils appearing on ridgetops and upper ridge crests, on about 23 percent of the Forest. Productivity, as related to tree growth, ranges from about 10 cubic feet/acre/year on shallow (<20 inches to bedrock), loamy-skeletal soils, usually in association with rock outcrops, to greater than 133 cubic feet/acre/year on deep (>40 inches to bedrock), well-drained soils found in flood plains, terraces, benches, toe slopes and coves. Shallow soils comprise less than one percent of the Forest and occur as either minor soils in a mapping unit name or as inclusions described in the mapping unit description, but not included in the mapping unit name.

Soils forming from mixed alluvial materials (e.g., limestone, quartzose sandstone and shale and siltstone) on terraces and flood plains are predominately well-drained, fine-sandy loam, loam and silt loam soils with high moisture availability and moderate fertility. Less extensive soils are somewhat poorly drained or have a fragipan, which restricts root growth and permeability. Riparian area soils, gravelly and cobbly loams, fine sandy loams, and sandy loams, developing from moderately coarse and coarse textured sediments, yield higher quality aquatic habitats (stable stream banks, clean, open-graded substrates, lower turbidities) than silt loam and loamy textured soils developing from silty alluvium (less stable stream banks, higher sediment yields, silty substrates, and increased turbidity). Soils in riparian areas generally exhibit distinct features that are influenced by flooding and/or a water table. Riparian soils will typically have free water (water table) available for plant use at some time during the growing season.

Soils on ridges are forming in weathered residuum from acid shale, siltstone, and sandstone, and to a limited extent, limestone, and carbonaceous shale and siltstone. They are mostly moderately deep-to-deep, well-drained, loam, silt loam, and silty clay loams with moderate fertility.

Soils on upland slopes are usually formed from colluvial materials of mixed mineralogy, derived from a variety of rock types. In cove positions, deep, well-drained silt loam and sandy loam soil have developed, offering highly productive growing sites. Soils on steep upper slopes range from moderately deep to shallow. They are well drained with the gravelly and channery silt loam and sandy loam textures commonly associated with rock outcrop. These soils generally have severe erosion potential from exposed or bare soil areas and a greater risk of slope failure. Soils in mid-slope and toe or lower slope positions are usually deep, well-drained, gravelly silt loams. Those below prominent sandstone cliffs are usually sandy loams.

Soils on the forest east of the Highland Rim (the Eastern Karst Plain subsection, the Knobs and Cliff subsections to the north), with the exception of the broader river valleys, have basically 40 to 80 percent quartz with some mica in the sand and silt size fraction. In the area of the Knobs subsection, soils have less than 60 percent quartz and mica minerals. Soils in the broad river bottoms along the Upper Cumberland and the Licking Rivers have sand and silt content comprised between 40 and 80 percent quartz.

Current Conditions

Soil Erosion: Erosion caused an annual loss of more than 86 million tons of soil from Kentucky lands from 1992 to 1996, according to the 1997 National Resource Inventory (USDA NRCS 1997), making it the state's most serious land management problem. Most people recognize, however, that well-managed forests are one of the most effective means of protecting watersheds.

Forests cover about one half of Kentucky's 25 million acres. However, vegetation management activities statewide, and particularly on the DBNF, generate a relatively small percentage of the total sources of non-point source pollution. Sheet and rill erosion in forests is of minor consequence. Channel and gulley erosion, though, is estimated to account for about two-thirds of the erosion and sediment yield problems in forested watersheds. Much of this is associated with roads. Most erosion and sediment yields originate from poorly maintained roads, many of which are not under Forest Service or other government jurisdiction, or from roads and skid roads associated with old logging operations on intermingled private property. In contrast, the land use generating the greatest loss of soil within the state is mining. In the mountains of eastern Kentucky, nearly 38 million tons of soil was eroded from 5 million acres from 1992 to 1996, according to the 1997 National Resource Inventory (USDA NRCS 1997). Eighty-seven percent of this loss comes from about 158,000 acres, 60 percent of which was strip mined for coal.

The biggest factor contributing to the amount of soil loss by erosion is the amount of bare soil created by an activity. With exposure comes the potential for soil movement through and off the areas where the disturbance occurs. Other important factors in soil erosion include soil texture, organic matter, infiltration/permeability rates, and slope. The highest sediment yields occur during the larger rainfall events. Since about 80 percent of estimated annual runoff and peak flood events occur from December through May, soils are more susceptible to erosion during this period.

Slope disturbances produced by construction of roads, skid roads, and log landings, etc., can potentially initiate or accelerate existing soil mass movement by undercutting or loading a slope, or disrupting established drainage patterns. Internal soil strength and external factors (e.g., root systems, ground water supplies, bedrock type) are important aspects of slope stability. Of particular concern are soils developing from shale's of these following formations or formation members: Beattyville, Hartselle, Magoffin, Pennington, Nada-Cowbell, and Nancy. These shale's weather to plastic clays, which increases the risk that soils will slump when subjected to a rapid rise in groundwater or concentrations of overland flow.

Slope stability on the Forest is of concern where soils are forming from soft incompetent shale's on steep slopes. These readily weather to plastic clays that are sensitive to disturbance or disruption of the hydrologic balance (e.g., a rapid rise in ground water). In many areas on the forest, topographic, lithologic, or structural conditions are particularly susceptible to landslides and debris flows when disturbed by road construction/reconstruction or logging. Such incipient slope failures can exert a tremendous impact on soil and water resources and cause serious economic losses due to blocked streams, degraded water quality, and loss of soil productivity. Accordingly, those engaged in locating, designing, constructing and maintaining roads, planning timber sales, and mineral development, etc., should be aware of how slope and groundwater interact with various sensitive soils and geologic formations. Not all landslides can be prevented, but they can be controlled, thus minimizing adverse effects to soil productivity and the benefits, functions and values of riparian areas and wetlands as well as water quality and aquatic habitats.

Stream Sedimentation and Water Quality: Soil erosion is the detachment and transport of individual soil particles by wind, water and gravity. Erosion not only reduces soil productivity, soil particles reaching streams as sediment, potentially lower the productivity of aquatic ecosystems. This, in turn, adversely affects various consumptive and non-consumptive uses. Sediment is the state's second leading cause of stream impairment, according to Kentucky's 2002 Clean Water Act 305b Report to Congress.

When soil erosion reaches the stream network, it is called stream sedimentation. The DBNF quantifies stream sedimentation using the Watershed Condition Rank (WCR) procedure developed by the Forest Service's Southern Region. Based on current as well as anticipated sediment load increases, WCR rankings indicate the condition of 5th level watersheds (Figure 3 - 2). A brief account of the process, as well as current conditions, follows. A full explanation of the process can be found in the process record for this Final Environmental Impact Statement.

To establish WCRs, the current sediment average annual yield is determined and expressed as a percentage above baseline conditions. Baseline conditions are calculated by removing all sedimentation attributed to present human influences in the analyzed watersheds. Next, the relative abundance of locally adapted species with respect to predicted sediment increases is used to determine a species-sediment load relationship or index (SSI). This score is modified using a weighted average when a watershed occurs in more than one physiographic zone. Watershed conditions are divided into three categories of Excellent, Average and Below Average. The SSI, however, does not necessarily indicate a precise watershed condition. It broadly categorizes watersheds based on the sediment prediction/aquatic viability relationship. As a relatively large-scale coarse filter used to evaluate forest plan alternatives, the SSI is a tool to help establish priorities at the planning level. Further, detailed analyses of watersheds are conducted at the project level.

WCR calculations are useful in the development of forest plan objectives. The following section details WCR outcomes with respect to adverse effects on aquatic biota as they are related to forest management:

> A watershed SSI of Excellent indicates a Low probability for adverse effect to aquatic species. If the results of a forest plan alternative remain within this range there should be no adverse effect on water quality with respect to beneficial uses (fish communities). Forest plan objectives, therefore, would focus on maintaining or improving aquatic health through the implementation of management prescriptions that support riparian values.
>
> A watershed SSI of Average**,** indicates a Moderate probability for adverse effects on beneficial uses. In this case, forest plan objectives should stipulate that watershed assessments be conducted during project planning to identify pollution sources. Additionally, objectives should provide for monitoring prior to project implementation to determine actual health of the biota.
>
> A watershed SSI of Below Average, indicates a High potential for adverse effects to beneficial uses. In addition to the objectives listed above, forest management at the project level should seek to maintain or restore watershed health and aquatic systems where Forest Service actions can make meaningful contributions to watershed health. Forest plan prescriptions should be applied in an effort to correct unhealthy situations.

The sediment model and the WCR both rely on numerous assumptions. To minimize any misunderstanding, every effort has been made to acknowledge assumptions and describe them

clearly. In light of these assumptions, however, neither the sediment model nor associated WCR should be regarded as absolutes. At the forest plan level, they are useful in comparing the outcomes that would likely result from the various alternatives. Regardless of assumptions or methods, the overall intention remains the reduction of risk to water quality and aquatic biota.

Watershed condition, expressed at the outfall of the watershed, reflects accumulation from disturbances across the entire watershed. Subwatersheds within a 5th level watershed will have a range of conditions. The conditions of subwatersheds and the determination of effects will occur at the project level.

On the DBNF, watersheds would fall into either the Excellent or Average category for stream sedimentation (Table 3 - 5). This is to be expected for 5th level watersheds on the Forest since most of the Daniel Boone is forested and under relatively strict erosion control measures or Best Management Practices (BMP). However, other water quality problems exist and are discussed in the paragraphs below.

Table 3 - 5. Watershed conditions by Management Area.

Watershed # (Figure 3 - 2)	Hydrologic Unit Code	Square Miles	Percent NFS Lands	Percent Increase over Baseline	Excellent Range	Average Range	Below Average Range	Species Sediment Load Index (SSI)*
Upper Cumberland River Management Area								
49	05130101350	39.6	5	1578	0 - 2200	2201 - 4700	> 4700	E
48	05130101360	16.7	17	944	0 - 2200	2201 - 4700	> 4700	E
37	05130101370	103.8	58	905	0 - 2200	2201 - 4700	> 4700	E
45	05130101400	130.9	19	571	0 - 2200	2201 - 4700	> 4700	E
43	05130101410	55.5	30	1441	0 - 2200	2201 - 4700	> 4700	E
44	05130101420	26.1	62	2123	0 - 2200	2201 - 4700	> 4700	E
41	05130101430	41.5	72	816	0 - 2200	2201 - 4700	> 4700	E
40	05130101440	12.8	54	864	0 - 2200	2201 - 4700	> 4700	E
35	05130101450	95.9	39	3196	0 - 2200	2201 - 4700	> 4700	A
20	05130102030	86.4	45	1393	0 - 2200	2201 - 4700	> 4700	E
23	05130102040	93.5	10	2094	0 - 2200	2201 - 4700	> 4700	E
19	05130102050	61.8	39	999	0 - 2200	2201 - 4700	> 4700	E
18	05130102060	143.8	7	2228	0 - 2200	2201 - 4700	> 4700	A
29	05130102070	112.9	47	1174	0 - 2200	2201 - 4700	> 4700	E
24	05130102080	40.6	4	677	0 - 2200	2201 - 4700	> 4700	E
32	05130102090	47.5	34	2366	0 - 2200	2201 - 4700	> 4700	A
34	05130102100	20.4	90	463	0 - 2200	2201 - 4700	> 4700	E
36	05130103010	56.8	61	990	0 - 2200	2201 - 4700	> 4700	E
39	05130103020	25.1	95	565	0 - 2200	2201 - 4700	> 4700	E
33	05130103040	37.8	10	908	0 - 2200	2201 - 4700	> 4700	E
38	05130104250	117.7	43	942	0 - 2200	2201 - 4700	> 4700	E
47	05130104270	49.7	6	1741	0 - 2200	2201 - 4700	> 4700	E
46	05130104290	62.6	61	546	0 - 2200	2201 - 4700	> 4700	E
42	05130104310	122.0	5	1131	0 - 2200	2201 - 4700	> 4700	E

(Table 3 – 5 cointues on next page)

Watershed # (Figure 3 - 2)	Hydrologic Unit Code	Square Miles	Percent NFS Lands	Percent Increase over Baseline	Excellent Range	Average Range	Below Average Range	Species Sediment Load Index (SSI)*
(continued from previous page)								
Licking River Management Area								
4	05100101040	98.9	57	1407	0 - 2200	2201 - 4700	> 4700	E
7	05100101090	34.5	11	1817	0 - 2200	2201 - 4700	> 4700	E
3	05100101100	85.0	32	974	0 - 2200	2201 - 4700	> 4700	E
6	05100101110	72.8	37	921	0 - 2200	2201 - 4700	> 4700	E
2	05100101130	186.5	30	1813	0 - 2200	2201 - 4700	> 4700	E
5	05100101140	56.0	28	1255	0 - 2200	2201 - 4700	> 4700	E
Middle Kentucky River Management Area								
16	05100204010	18.0	3	849	0 - 2200	2201 - 4700	> 4700	E
17	05100204020	110.9	9	1574	0 - 2200	2201 - 4700	> 4700	E
13	05100204030	60.0	10	1313	0 - 2200	2201 - 4700	> 4700	E
12	05100204040	74.8	9	828	0 - 2200	2201 - 4700	> 4700	E
14	05100204050	120.2	27	878	0 - 2200	2201 - 4700	> 4700	E
11	05100204060	27.8	11	1138	0 - 2200	2201 - 4700	> 4700	E
15	05100204070	69.8	2	1407	0 - 2200	2201 - 4700	> 4700	E
8	05100204120	134.2	50	1076	0 - 2200	2201 - 4700	> 4700	E
10	05100204140	66.4	21	1073	0 - 2200	2201 - 4700	> 4700	E
9	05100204170	27.3	9	1108	0 - 2200	2201 - 4700	> 4700	E
50	05100201230	8.3	0	1551	0 - 2200	2201 - 4700	> 4700	E
Upper Kentucky River Management Area								
31	05100202010	242.8	8	866	0 - 2200	2201 - 4700	> 4700	E
30	05100202020	92.0	0	1587	0 - 2200	2201 - 4700	> 4700	E
25	05100202030	84.2	19	443	0 - 2200	2201 - 4700	> 4700	E
28	05100203010	195.6	61	637	0 - 2200	2201 - 4700	> 4700	E
21	05100203020	129.8	17	634	0 - 2200	2201 - 4700	> 4700	E
26	05100203030	29.5	35	321	0 - 2200	2201 - 4700	> 4700	E
27	05100203040	228.6	14	902	0 - 2200	2201 - 4700	> 4700	E
22	05100203050	71.3	8	875	0 - 2200	2201 - 4700	> 4700	E

** Species Sediment Load Index (SSI): E = Excellent, A = Average

Other Activities Affecting Water Quality: As discussed above, erosion and stream sedimentation are the major water quality problems affecting the Forest. There are other pollutants that are causing serious impacts in several watersheds, however. These include mineral extraction, sewage discharge, and agricultural run-off.

Within the proclamation boundary, 331 miles of stream do not support or only partially support beneficial uses, e.g., recreation and aquatic life (Kentucky Division of Water 1996; Table 3 - 6). Only 21 of these stream miles flow through National Forest System land (Table 3-6a).

Sedimentation and acid mine drainage from abandoned surface and underground coal mines; brine and oil residue from oil drilling; sedimentation and runoff of agricultural chemicals and animal wastes from farm lands; discharge from domestic wastewater systems; and sedimentation from roads

and timber harvest constitute the primary water quality issues facing the DBNF. The source of many of these problems can be found on private lands near or adjacent to the Forest.

Table 3 - 6. Miles of impaired streams within the DBNF proclamation boundary.

MANAGEMENT AREA	River Basin	Miles of Impaired Streams
Licking River	Licking	1.0
Middle Kentucky River	Kentucky	91.0
Upper Kentucky River	Kentucky	115.9
Cumberland River	Cumberland	117.7
	Total	330.8

(KY DOW 1996)

Table 3 - 7. Miles of impaired stream on National Forest System land.

Watershed # (Figure 3 - 2)	Hydrologic Unit Code	Miles of Impaired Streams
Licking River Management Area		
5	05100101140	0.0
Middle Kentucky River Management Area		
8	05100204120	1.2
10	05100204140	1.0
Upper Kentucky River Management Area		
28	05100203010	0.2
Upper Cumberland River Management Area		
19	05130102050	0.5
20	05130102030	0.3
23	05130102040	0.9
29	05130103070	4.7
32	05130102090	0.0
34	05130102100	0.0
36	05130103010	0.7
38	05130104250	1.8
39	05130103020	0.6
41	05130101430	1.7
44	05130101420	1.6
45	05130101400	0.5
46	05130104290	2.3
47	05130104270	2.8
	Total	21.4

(KY DOW 1996)

Water Use: The U.S. Department of Interior Geological Survey has estimated the nation's water use at five-year intervals since 1950. Early estimates were for whole states and even larger watersheds. In 1985, however, the agency began estimating use for counties and watersheds (hydrologic units) that tend to be slightly larger than a typical county. State totals for these periodic surveys of water use have been published in Geological Survey circulars. The Geological Survey also provides detailed water use and supply estimates as data files (USGS 2002). For this Draft Environmental Impact Statement, water use information was retrieved by 4th level hydrologic unit (HUC) and then aggregated by Management Area (Figure 3 - 1). Estimates are reported for total ground water and surface-water uses including domestic, municipal, industrial, agricultural (for irrigation), thermoelectric (largely for cooling), and hydroelectric uses (Table 3 - 8). Of the water withdrawn, a portion is consumed (e.g., by being incorporated into a product or evaporated from an irrigated field) and is removed from the immediate water environment; the remainder returns to the stream or perhaps seeps into ground water storage and is available for reuse.

Table 3 - 8. Water use in millions of gallons per day by Management Area.

MANAGEMENT AREA	Year	Ground-water Use	Surface-water Use	Total Use
Licking River	1985	3.62	24.05	27.67
	1990	5.19	21.92	27.11
	1995	2.46	34.65	37.11
Middle Kentucky River	1985	4.01	8.35	12.36
	1990	4.42	13.44	17.86
	1995	2.71	13.15	15.86
Upper Kentucky River	1985	1.74	2.08	3.82
	1990	1.81	3.39	5.20
	1995	1.27	6.65	7.92
Upper Cumberland River	1985	6.23	255.44	261.67
	1990	7.58	416.45	424.03
	1995	3.74	420.57	424.31

Environmental Effects

EFFECTS COMMON TO ALL ALTERNATIVES

DIRECT AND INDIRECT EFFECTS COMMON TO ALL ALTERNATIVES

The following discussion provides some background information regarding the direct environmental effects common to soil and water resources from management activities. Any activity that disturbs the land surface, decreases cover or alters vegetation can affect soils, water yield and degrade water quality. The primary management activities that could affect the soil resource, water yield, and water quality are:

- Roads and Trails
- Vegetation Management

- Mineral Exploration
- Fire Management

Roads and Trails: Roads and trails directly and indirectly affect water by increasing sedimentation and concentrating runoff. Roads and trails expose and compact soils, alter surface and subsurface water flow, and can alter stream channels during construction. When left open they will contribute to higher erosion and sedimentation rates than closed roads and trails.

Vegetation Management: Vegetation management activities that affect soil and water are timber harvesting, site preparation, timber stand improvement projects, and skid trail construction. Loss of the protective soil cover (litter) from ground disturbance can increase erosion and sedimentation while decreasing soil productivity. Water yield also increases because of reduced transpiration and raindrop interception.

Mineral Exploration: Mineral exploration and development can affect soil and water by increasing erosion and sedimentation, soil compaction, and water yield. In many cases soil productivity is reduced and sediment can affect water quality. The potential seepage or spillage of toxic substances from mining facilities or disposal areas may also pose a threat to water quality.

Fire Management: Prescribed burning directly affects soil and water by removing a portion of the vegetative cover, which exposes soil to erosion. Control lines also expose mineral soil. These factors can reduce soil productivity and increase stream sedimentation. The significance of this varies widely depending on the soils, topography and the intensity of burn.

Since many of the activities proposed in the Forest Plan result in the same impacts to the soil and water resource the individual effects will be addressed in the following sections. At this scale of planning, the following discussions will be somewhat general in nature, more qualitative than quantitative.

Erosion and Sedimentation

The principal activities that raise the likelihood erosion and stream sedimentation are road construction, construction of log landings, skid roads, mechanical site preparation, and construction of drill pads for exploration and production of oil and gas and illegal use of off-highway vehicles (OHVs). The key to sustaining soil productivity and their hydrologic functions and water quality in the long-term is protection of the forest floor and associated soil properties and qualities through implementation of a mix of Best Management Practices (BMPs). Implementation of BMPs can safeguard long-term soil productivity and the hydrologic functions of soils as susceptible to erosion. With successful revegetation of bare soil areas, erosion and sedimentation rates should diminish rapidly to pre-disturbance levels within three years. The greatest decrease in these respective rates should be achieved in the first two growing seasons.

Soil erosion risk is greatest immediately after soil disturbing activities are completed. If Best Management Practices (e.g. structural drainage controls and revegetation) are followed, however, soil loss is usually negligible by the third and fourth year (Burger, 1985). Erosion damage associated with vegetation management activities is, therefore, largely preventable. The most effective way to reduce soil erosion is to limit the area disturbed as well as the area of bare soil conditions.

Although normally an added cost and complexity, cable logging systems are most effective in reducing adverse effects of timber harvest on soils and water quality. Carefully planned harvests that employ cable logging can reduce access needs (e.g. temporary roads, skid roads) by about 25 to 50 percent when compared to harvest that rely on ground-based or conventional logging equipment, such as tracked and wheeled skidders or even draft animals (Patric 1984).

Soil Displacement

The horizontal displacement of mineral surface soil layers rich in organic matter from one place to another through mechanical means (e.g., skidding of logs, blade construction of skid roads, landings, temporary and system roads, etc.), as well as accelerated and natural erosion, can reduce nutrient supplies and available soil water and increase soil densities. All of these are important to plant growth. Different soils have varying sensitivity to displacement of surface layers due to variation in soil properties and qualities (e.g., topsoil depth, texture, structure, and stoniness) and other factors (e.g., slope, vegetative cover). The degree of displacement may increase with increasing slope gradient. Soil loss can directly impair short- and long-term productivity because soil is a non-renewable resource. Root damage from skidding of logs and mechanical scattering may reduce tree vigor and resistance to disease and insect damage. Since over 60 percent of the fine root system (biomass) occupies the top eight inches, over 80 percent in the surface to 16 inches, and over 95 percent in the top 40 inches of deep soils, minimizing soil displacement to protect long-term productivity is imperative.

Soil Compaction

Soil compaction impacts can alter soil structure, reducing the larger pores and pathways in the soil, decreasing macrospore space, infiltration, and permeability (macrospores are soil voids >14 micrometers (um) or millionths of a meter), and increasing soil density. This will increase runoff, erosion, and stream sedimentation. In addition, when compaction approaches the projected growth limiting density for tree roots (Daddow and Warrington 1983), it reduces the volume of soil available for exploitation by tree roots as well as the productive potential of the impacted area (Gent, Jr. et al. 1983; Tworkoski et al. 1983).

The extent to which a forest soil is compacted depends on the kinds of equipment used (e.g., tracked, rubber tired, or low ground pressure equipment and cable systems), their weight, the number of trips made over the same area, the volume of timber skidded, and the depth of litter/duff layers and presence of slash, soil textures, structure, and soil moisture content. Designating the location of skid roads, however, can reduce the area of compaction and protect soil productivity. The compacted area can be reduced by spacing skidding routes as evenly as possible throughout the harvest area, providing soil resource protection and economic efficiency. Winching or end lining logs to the machine rather than driving the machine from a skid road/trail to each individual log also decreases the area compacted.

The impacts of compaction on plant growth can persist for as long as several decades, depending on the kind of soil and degree of impact. Even with soil tillage (e.g., ripping, subsoiling, or disking) these impacts cannot be fully alleviated in the short-term. Tillage with the proper equipment and under optimum soil conditions, however, can improve plant survival and growth substantially (estimated 30-75 percent) in the short-term. Tillage can improve soil recovery over the natural processes of freezing and thawing and wetting and drying cycles, animal activity, and root growth.

The potential loss in productivity from compaction is an important consideration on the forest in that approximately 70 percent of the soils occurring on slopes most favorable for conventional or crawler tractors and wheeled skidders (<35 percent slopes) have medium to high compaction hazard. Additionally, these soils are generally the most productive on the forest as well.

Slope Stability

Slope stability involves a complex interaction of soil shear strength, soil depth, slope gradient, ground water rise as related to precipitation and tree root strength. Decisions regarding slope stability cannot be made without risk. All sloping soils seek to achieve a flat gradient over time as influenced by erosion and landslides. Assessments of stability and risk/hazards should be correlated with geologic formations/bedrock types frequently associated with slope failures (e.g., characteristics such as competency or rock strength, lithologic discontinuities, hydrogeological conditions/hydraulic conductivity and porosity, weathering, clay mineralogy, and strike and dip of beds). Risk ratings of "severe or moderate" do not necessarily indicate an imminent or incipient failure, however. Such ratings mean only that serious adverse impacts are likely if a rapid rise in groundwater occurs.

Timber harvest systems that leave live trees spaced throughout the harvest area (e.g., shelterwood harvest) help provide stability by maintaining an abundance of live roots and a level of evaporation/transpiration from the residual trees. This reduces pore water pressure in the soil profile, increasing shear strength or resistance to a potential slope failure. The greater residual basal area left remaining after harvest and site preparation, the greater the significance of this benefit.

Water Quantity/Water Use

Most water quantity or water yield changes in streams on the DBNF over the life of the 2004 Forest Plan would be related to vegetation manipulation. Water yield in the streams typically increase temporarily after harvesting. This is caused by soil compaction and the removal of vegetation that would normally intercept and transpire rainfall. Most water yield increases from National Forest System lands are usually small and may not correlate with or alter peak flows. These changes in water yield usually augment summer low-flows (Swank, et al. 1989). Much depends on soil and site conditions, storm intensity and duration, as well as antecedent soil moisture conditions (Lull and Sopper 1966; Anderson et al. 1976). The amount and duration of this increase also depends on the percentage of basal area removed as well as forest type. Timber harvesting in pine generates a greater increase in total water yield than hardwoods or mixed pine-hardwood types. A 91 percent recovery in water yield can be expected within 10 years after removing 95 percent of the basal area in hardwood forest types. This recovery would take slightly longer for pine but would be quicker for partial cuts or thinnings. In all the alternatives most vegetation manipulation would be done with partial cuts. Because of southern pine beetle (SPB) infestation, very little pine would be harvested. However, the water yield changes from SPB affected areas were taken into account. The increase in surface runoff may cause some soil movement, minor stream bank cutting, and possibly stream sedimentation, but these increases may also temporarily increase aquatic species habitat in headwater areas by providing more water during summer low-flow.

To evaluate indirect effects of the alternatives, projected increases in total water yield were determined using an equation developed by researchers at the U.S. Fish and Wildlife Service Coweeta Research Laboratory for the Appalachian Mountains (Douglas and Swank 1972, 1975).

Although the equation was modified to better represent conditions on the DBNF, the reliability of these changes are predicted to be only within one level of magnitude of actual water yield increases (Chalfant 1990). Water yield would also vary according to the percentage of the watershed harvested and the location of harvest units within the watershed. Predicted water yield changes are, therefore, best used for comparison of alternatives and not as absolute values.

The projected water yield increases were also compared to water use in each of the Management Areas/watersheds (USGS 2002). Currently, water supply vastly exceeds use in most areas of the four main watersheds. In a few locations, however, use has risen to consume a substantial portion of the supply, especially during drought conditions. Future water demand is expected to follow population growth.

CUMULATIVE EFFECTS COMMON TO ALL ALTERNATIVES

Erosion and Sedimentation

Sedimentation originating from both private and National Forest System lands is the primary cause of reduced water quality. As previously discussed, a majority of the sedimentation is introduced into stream channels from soil disturbing activities such as roads, timber harvesting, off-highway vehicle use, and fire lines (Swank et al. 1989). Sediment is an appropriate measure to determine the effects of management activities on water quality and its associated beneficial uses on forested lands (Coats and Miller 1981). Sediment increases can adversely affect aquatic species productivity and diversity, degrade drinking water, and affect recreational values.

To evaluate the alternatives, the Forest's four Management Areas were divided into 49 administrative watersheds (Figure 3 - 1). The size of these watersheds ranges from 5,316 to 155,398 acres and are modified USGS 5th level hydrologic units. The average watershed size used in this analysis is approximately 51,300 acres. The cumulative effects for each alternative on all 49 watersheds were evaluated separately.

As discussed in the Soil and Water Affected Environment section, stream sedimentation numbers were estimated using the Forest Service Southern Region Watershed Condition Rank procedure. For each alternative, the total stream sedimentation numbers represent an estimate of erosion that would reach the stream network from private as well as Forest Service activities (Table 3 - 9). These sedimentation numbers have been estimated for the next five decades. Since the results for each decade are very similar, only the first decade has been reported in this Draft Environmental Impact Statement.

Due to natural variability, geography, climatic conditions, and some of the assumptions on which stream sediment values are based, it is important to view these numbers as comparative rather than absolute values. Most stream sedimentation occurs in the first three years after a soil disturbing activity.

Table 3 - 9. Percent Sediment Increase above existing conditions due to Private and Forest Service Activities.

Map Number (Figure 3 - 2)	HUC	A	B1	C	C1	D	E1
2	5100101130	1.02	0.16	0.76	0.76	0.76	0.78
3	5100101100	1.26	0.14	0.97	0.97	0.97	0.98
4	5100101040	1.70	0.18	1.29	1.35	1.38	1.40
5	5100101140	1.25	0.12	1.00	1.00	1.00	1.00
6	5100101110	1.56	0.17	1.23	1.23	1.23	1.24
7	5100101090	0.23	0.03	0.19	0.19	0.19	0.18
8	5100204120	0.94	0.18	0.84	0.84	0.84	0.77
9	5100204170	0.41	0.08	0.46	0.46	0.46	0.42
10	5100204140	0.76	0.14	0.81	0.81	0.81	0.75
11	5100204060	0.56	0.13	0.63	0.63	0.63	0.59
12	5100204040	0.47	0.09	0.46	0.46	0.46	0.43
13	5100204030	0.42	0.09	0.41	0.41	0.41	0.38
14	5100204050	2.07	0.35	2.28	2.28	2.28	2.14
15	5100204070	0.11	0.02	0.12	0.12	0.12	0.11
16	5100204010	0.17	0.04	0.15	0.15	0.15	0.14
17	5100204020	0.83	0.20	0.99	0.99	0.99	0.94
18	5130102060	0.50	0.09	0.75	0.75	0.75	0.78
19	5130102050	3.08	0.24	4.67	4.67	4.67	4.85
20	5130102030	4.37	0.32	6.85	6.85	6.85	7.08
21	5100203020	0.81	0.17	0.57	0.57	0.57	0.59
22	5100203050	0.38	0.08	0.26	0.26	0.26	0.27
23	5130102040	0.50	0.11	0.70	0.70	0.70	0.73
24	5130102080	0.44	0.04	0.61	0.61	0.61	0.64
25	5100202030	1.23	0.24	0.78	0.78	0.78	0.82
26	5100203030	2.08	0.38	1.26	1.26	1.26	1.31
27	5100203040	0.73	0.16	0.54	0.54	0.54	0.56
28	5100203010	4.40	0.87	3.39	3.44	3.50	3.61
29	5130102070	5.07	0.37	8.06	7.98	7.98	8.26
30	5100202020	0.00	0.00	0.00	0.00	0.00	0.00
31	5100202010	0.33	0.07	0.22	0.22	0.22	0.23
32	5130102090	2.14	0.20	3.38	3.38	3.38	3.46
33	5130103040	1.48	0.12	2.38	2.38	2.38	2.43
34	5130102100	16.49	1.32	26.00	26.00	26.00	26.34
35	5130101450	1.99	0.22	3.17	3.17	3.17	3.25
36	5130103010	8.09	0.61	12.56	13.14	13.43	13.81
37	5130101370	6.57	0.50	10.42	10.38	10.38	10.71
38	5130104250	4.26	0.33	6.50	6.42	6.42	6.70
39	5130103020	12.75	0.97	20.72	20.72	20.72	20.96
40	5130101440	4.69	0.43	7.29	7.29	7.29	7.29
41	5130101430	9.36	0.75	14.78	14.78	14.78	15.11
42	5130104310	0.68	0.07	1.04	1.04	1.04	1.08
43	5130101410	2.17	0.19	3.42	3.42	3.42	3.52
44	5130101420	2.64	0.28	4.06	4.06	4.06	4.13
45	5130101400	2.29	0.24	2.95	2.95	2.95	3.20
46	5130104290	7.80	0.59	12.11	12.11	12.11	12.53
47	5130104270	0.24	0.06	0.35	0.35	0.35	0.35
48	5130101360	0.48	0.06	0.44	0.44	0.44	0.51
49	5130101350	0.16	0.07	0.16	0.16	0.16	0.17
50	5100201230	0.02	0.02	0.02	0.02	0.02	0.02

Water Quality

As discussed in the Affected Environment portion of the Soil and Water section, erosion and stream sedimentation are the major water quality problems on the Forest and will be discussed for each alternative. However, other pollutants are causing serious impacts in several watersheds such as those associated with mineral extraction, sewage discharge, and agricultural run off. These activities occur mostly on private lands, however. None of the proposed activities for National Forest System land would alter overall water quality to a great extent, but some localized impacts could occur. While private activities affecting water quality may change in the next decade, the location, severity, and timing of these actions are difficult to project.

The miles of user-developed off-highway vehicle (OHV) trails vary widely between watersheds and through time. Since 1998, numerous miles of OHV trails on National Forest System land have been closed. However, during this time total miles of user-developed trails per watershed decreased only slightly as new ones were created on both private as well as National Forest System land. Trail erosion can decrease water quality by generating stream sedimentation. These effects vary widely depending on access, current legal use, and population.

OTHER EFFECTS COMMON TO ALL ALTERNATIVES

Long-term Soil Productivity/Nutrient Cycling

Soil productivity is classified by the natural capability of the soil to sustain the growth of plants and plant communities over time. In addition, any measure of soil productivity must consider the maintenance of soil properties and qualities for protection of water quality and forest health. Since most Forest uses ultimately depend on productive soil, maintenance and enhancement of long-term soil productivity is a basic requirement of resource management on the DBNF.

Vegetation management practices, more specifically road building, invariably have the potential to degrade soil quality and health, impairing the soil's capacity to perform its functions of sustaining plant and animal (including soil microflora and microfauna) productivity. In addition, forest health can be correlated with soil quality in regard to the incidence of various diseases (e.g., littleleaf disease, annosum root disease, and oak decline) and different invasive insect species (e.g., southern pine beetle, gypsy moth, and other bark beetles), affecting tree growth and mortality. Poor and/or damaged soils increase moisture stress and nutrient deficiencies, which in turn increase susceptibility to disease infections and invasive insect infestations (Briggs 1993). Studies indicate that nutrient losses from timber harvests can be comparable to nutrient inputs, resulting in no long-term reduction of the ecosystem's productive potential (Kimmins 1977; Wells and Jorgensen 1978; Patric 1980; Grier et al. 1989). Nutrient losses from timber harvest were found to be small to negligible since such losses are a small fraction of the total nutrient capital, site productivity would not be reduced (Sopper 1975).

Demands on the soil potentially exceed the natural nutrient supplying capacity of the system only where timber harvest is coupled with mechanical piling or windrowing of slash and all other woody and organic material on the forest floor. Even then, the quantitative effects of this more intensive treatment on the biological, chemical, and physical processes in the soil are not sufficiently known to fully predict the long-term impact on soil productivity. Measurement of statistically significant

treatment differences is complicated by wide variation in forest soil nutrient levels (Miller and Sirois 1986).

Timber harvest can release nutrients bound in the soil and biomass by increasing soil temperature as well as the amount of light and water available to the forest floor. These factors all accelerate decomposition of organic matter along with the organic constituents included in the residual logging slash. As organic matter levels rise, soil microorganisms play an instrumental role in the conversion to humus, a relatively stable form of carbon sequestered in soils for long periods (decades and even centuries). Soils in the proposed treatment areas in all alternatives are capable of retaining released nutrients rather than losing them through drainage or volatilization.

In contrast to the potential effects of logging on productivity and nutrient cycling, fallen trees, windblown or killed by insects or disease, would improve local soil productivity over the long-term if left in place. Tree decay enriches nutrient capital, enhancing many biological processes and physical attributes important for soil development and management.

Predicting the Forestwide effects of various disturbance activities on soil productivity is complicated by many factors. These include the spatial and temporal variability of soil properties and qualities as well as site-specific conditions (e.g., slope steepness, landform position, soil depth, soil textures), weather, and intensity of various disturbances. Instead of calculating a statistical probability of change, the art and science of forest management can predict the potential effects of proposed management activities on soil productivity only in general terms.

This effects analysis was limited to National Forest System lands. Only at the project level will potential effects from management of private lands be considered. In general, management of private lands has little direct or indirect influence on long-term soil productivity on National Forest System lands. In contrast, hydrologic responses (e.g., water quality, quantity and timing of streamflows, stream channel stability) are often linked directly with management activities on private lands. No cumulative effects to soils, therefore, are anticipated from implementation of the 2004 Forest Plan.

The application of Forestwide Standards and other resource protections limit the extent and duration of adverse environmental effects. Nevertheless, some adverse impacts to soils from management actions are unavoidable. These actions represent a commitment of soil resources necessary to support management as proposed in each alternative. Utilization of some acreage on the Forest is necessary to develop the infrastructure needed for sustainable production of goods and services as well as for restoration of lands damaged from mining, logging, etc., prior to their acquisition by the Forest Service. Careful planning and implementation of appropriate Standards can minimize most impacts to soil productivity. Under good stewardship, most adverse impacts should be low to moderate.

Many of the potentially affected acres would be dedicated to future use and management of the Forest over the long-term (i.e., ecosystem management). Projections of short- and long-term commitment of soils are shown in Table 3 - 10.

Table 3 - 10. Estimated short- and long-term soil impacts during the first decade of Plan implementation.

INDICATOR	ACRES BY ALTERNATIVE					
SHORT-TERM EFFECTS	**A**	**B-1**	**C**	**C-1**	**D**	**E-1**
Vegetation management	4,200	1,602	4,203	4,203	4,203	4,255
Prescribed fire	4,130	770	6,364	6,364	6,364	770
Fire lines	233	30	233	233	233	80
Total short-term soil impacts	8,563	2,402	10,800	10,800	10,800	5,105
Percent of Forest with short-term soil impacts	1.3%	0.4%	1.6%	1.6%	1.6%	0.8%
LONG-TERM EFFECTS	**A**	**B-1**	**C**	**C-1**	**D**	**E-1**
Classified roads	430	106	675	675	675	806
Temporary roads	107	26	169	169	169	202
Timber harvest	5,224	1,535	7,375	7,375	7,375	8,870
Developed recreation	555	555	555	555	555	555
Motorized & non-motorized trails	363	204	363	408	451	451
Administrative & communication sites	40	40	40	40	40	40
Oil and gas development	76	42	90	90	90	118
Other mineral development	529	529	529	529	529	529
Total long-term soil impacts	7,324	3,037	9,796	9,841	9,884	11,571
Percent of Forest with long-term soil impacts	1%	0.4%	1.4%	1.4%	1.4%	1.7%
TOTALS						
Total soil impacts	15,887	5,439	20,596	20,641	20,684	16,676
Total short-term soil impacts	8,563	2,402	10,800	10,800	10,800	5,105
Total long-term soil impacts	7,324	3,037	9,796	9,841	9,884	11,571
Percent of Forest with soil impacts	2.3%	0.8%	3.0%	3.0%	3.0%	2.4%

ALTERNATIVE A

DIRECT AND INDIRECT EFFECTS

Erosion and Sedimentation

Accelerated erosion is an unavoidable consequence of such management activities as road construction, timber harvest, and to a lesser degree, recreational uses such as off-highway vehicle trails and heavily used dispersed camping sites.

The soil disturbances that would result from implementation of Alternative A could increased the risk of accelerated erosion and sedimentation rates on 11,345 acres of National Forest System land during the first decade of the 2004 Forest Plan.

Soil Displacement

Removal of surface soil layers, rich in nutrients as well as numbers and diversity of soil microorganisms, can have a strong adverse influence on soil productivity. Under Alternative A, about 7,215 acres would be subject to some level of soil displacement.

Soil Compaction

Soil compaction results in soil conditions less favorable for plant growth. With repeated passage of heavy equipment, off-highway vehicles, and foot traffic, soil compaction can occur on all soils developing on the forest. The area disturbed and compacted increases with each succeeding harvest entry, commercial thinning, and final harvest followed by mechanical site preparation.

Over the first 10 years of the 2004 Forest Plan, compaction generated by operation of heavy machinery while harvesting timber, doing mechanical site preparation, construction of roads, drill pads, fire lines, etc., would likely have an adverse effect on about 13,930 acres.

Fire

The effects of prescribed fire on soil productivity can vary with soil conditions (e.g., antecedent soil moisture), soil properties, and qualities, as well as the type, extent, intensity, and duration of the burn plus fuel loads and conditions. Where fire is of such duration and intensity that it affects soil biota, structure, organic matter, and fertility, it may potentially trigger accelerated erosion and loss of soil nutrients. Suspended solids, sediments, and dissolved salts in streamflow would increase nutrient enrichment.

This analysis presumes that three percent of the acreage treated with prescribed burning would likely be burned severely, therefore, as many as 4,130 could be affected. A severe burn consumes organic matter on surface and within the upper half-inch of the mineral soil, visibly altering soil structure and/or color. Hydrologic condition and function of soils and their productive potential also are harmed in the short-term.

Slope Stability

When soils are displaced and/or buried from slope failures, natural or human caused, the original site becomes less productive. Removal of tree cover from soils can accelerate the occurrence of landslides due to loss of root strength in soils prone to failure. Furthermore, changes in infiltration and permeability rates associated with timber harvest and road building affect soil stability.

Relative slope stability risks, at the Forestwide scale for Alternative A, are projected to be about 12.5 percent. These risks were based on calculated factor-of-safety values, supplemented with recorded and general field observations over time as to the tendency of individual soils to slide or slump both naturally and where disturbed by various management actions. The most accurate scrutiny, evaluation, and estimation of stability risks occur only at the project-level scale.

The relative risk ratings used to derive this conclusion are Low, less than 10 percent risk; Moderate or Medium, 10-30 percent risk; and Severe, greater than a 30 percent risk. This represents a ratio of acres proposed for vegetation management to acres recognized as having higher stability risks. These values are considered “incremental risk” associated with projected vegetation management and road construction activities in support of each alternative. This is in addition to background risks that may

exist with slope stability independently of implementation of each alternative or absence of land management activities.

Water Quantity/Water Use

The effects of changes in water yield by Management Area for Alternative A are shown in Table 3 - 11. The difference in water yields is expressed as the percent of increase over natural yields and range from 0.23 to 0.86 percent. Water yield varies widely by time of year, intensity, and duration of storms, antecedent moisture conditions, as well as the timing of concentration of contributing flows. Water yield increases similar to those in Alternative A, less than two percent, would probably go undetected. Localized increases could be larger than those reported in Table 3 - 11, but such effects would be more appropriately addressed at the project level.

Based on local knowledge and field observations, stream channels within the DBNF are usually stable and capable of handling the small increases in flow projected for this alternative without causing channel erosion. This is particularly true of water yield increases that occur during summer low-flow periods. Table 3 - 11 also shows how the projected increases in water yield for Alternative A compares with the 1995 water use data by Management Area. As the table shows, the projected increases are relatively small (< 5 mg/d). In any case, supply far exceeds demand on most occasions. Any increases in summer low-flow, if detectible, would benefit local water users and instream uses. However, any action under this alternative would likely have little effect on local water supplies or aquatic biota.

Table 3 - 11. Water yield and water use increases by Management Area for Alternative A.

MANAGEMENT AREA	% Water Yield Increase	Water Yield Increase (millions of gallons per day)	Total Water Use (millions of gallons per day)
Licking River	0.43	2.08	37.11
Middle Kentucky River	0.23	1.10	15.86
Upper Kentucky River	0.36	1.77	7.92
Upper Cumberland River	0.86	4.19	424.31

CUMULATIVE EFFECTS

Erosion and Sedimentation

As shown in Figure 3 - 3, the projected increase in stream sediment from erosion on both private and National Forest System lands would range from 0.02 to 16.49 percent. Given the natural variability of stream sedimentation, even cumulative changes within this range should be negligible on a 5th level watershed scale and should not change the Watershed Condition Rank for any of the watersheds. The Analysis revealed that 25 watersheds are in Excellent condition and three are in Average condition.

The risk of increased cumulative effects from erosion on National Forest System lands should remain low. Implementation of appropriate Standards should minimize soil loss, safeguarding long-term soil productivity and water quality. Successful revegetation of disturbed soils, normally achieved within two or three growing seasons, can return erosion rates to pre-disturbance levels.

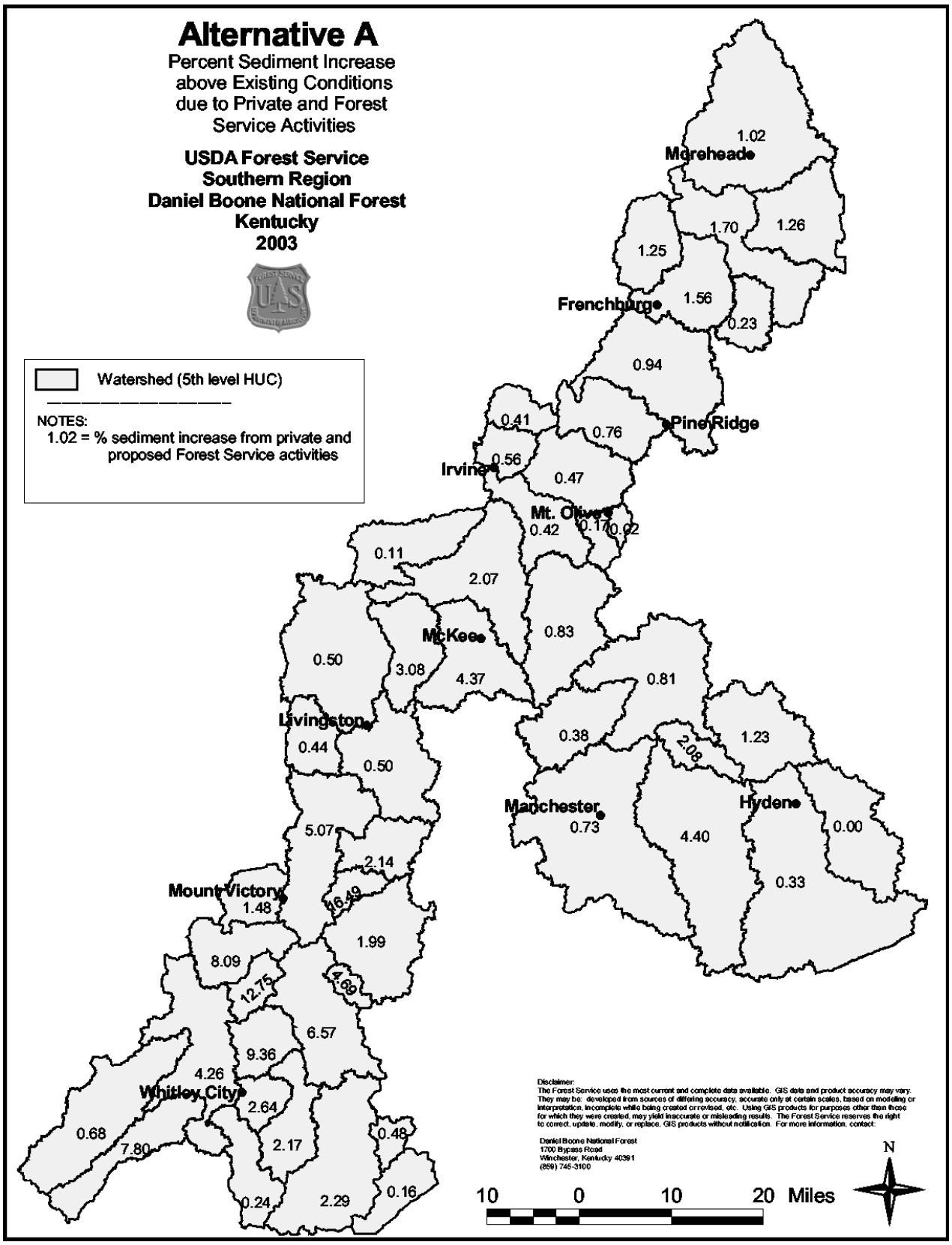

Figure 3 - 3. Cumulative stream sediment increases by watershed.

OTHER EFFECTS

Long-term Soil Productivity/Nutrient Cycling

Implementation of Alternative A and its potential effects on soil resources, excluding roads, which are dedicated to long-term use and Forest management, would have a moderate effect on long-term soil productivity. Long-term effects would impact approximately 7,324 acres, or about one percent of National Forest System lands. The productive potential of affected soils would likely be reduced by 5 to 15 percent.

Many impacts to soils are unavoidable. Utilization of some acreage is necessary to develop the infrastructure, such as roads, needed for sustainable production of goods and services from the Forest.

In general, soil productivity across the Forest is judged to be stable or improving. Only localized declines in soil productivity are taking place. Those declines are due to soils lost or displaced by erosion as well as soils moved or compacted during the construction of roads, log landings, or drilling pads/pits, etc. While such uses have increased soil loss and soil resource commitment Forestwide, the overall impact remains low.

ALTERNATIVE B-1

DIRECT AND INDIRECT EFFECTS

Erosion and Sedimentation

Accelerated erosion is an unavoidable consequence of many forest management activities such as road construction, timber harvest, and, to a lesser degree, recreational uses such as off-highway vehicle trails and heavily used dispersed camping sites.

Implementation of various management prescriptions is projected to generate an increased risk of accelerating erosion and sedimentation rates on 2,933 acres for the first decade of the 2004 Forest Plan.

Soil Displacement

Removal of surface soil layers, rich in nutrients as well as the number and diversity of soil microorganisms, can adversely influence soil productivity to a great degree. Under Alternative B-1, an estimated 2,829 acres would be subject to some amount of surface soil displacement.

Soil Compaction

Soil compaction results in less than favorable conditions for plant growth. Repeated passage of heavy equipment, excessive use of off-highway vehicles, and even foot traffic, can cause compaction of any soil on the DBNF. Each succeeding harvest entry, commercial thinning, or final harvest followed by mechanical site preparation, can disturb or compact a wider area.

Over the first 10 years of the 2004 Forest Plan, compaction generated by operation of heavy machinery while harvesting timber, doing mechanical site preparation, construction of roads, drill pads, fire lines, etc., would likely have an adverse effect on about 3,711 acres.

Fire

The effects of prescribed fire on soil productivity can vary with soil conditions (e.g., antecedent soil moisture), soil properties and qualities, as well as the type, extent, intensity, and duration of the burn plus fuel loads and conditions. Where fire is of such duration and intensity that it affects soil biota, structure, organic matter, and fertility, it may trigger accelerated erosion and loss of soil nutrients. Suspended solids, sediments, and dissolved salts in streamflow would increase nutrient enrichment.

An estimated three percent of all acres burned by prescribed fire are likely to be burned severely. A severe burn consumes all organic matter on the soil surface and within the upper half-inch of the mineral soil, visibly altering soil structure and/or color. Additionally, the hydrologic condition and function of severely burned soils, as well as their productive potential, are harmed in the short-term. Under Alternative B-1 as many as 770 acres would likely be burned severely by prescribed fire.

Slope Stability

When soils are displaced or buried by slope failures, the original site becomes less productive. Removal of tree cover and the loss of root strength in soils prone to failure can accelerate the occurrence of landslides. In addition, changes in infiltration rates and permeability associated with timber harvest and road building affect soil stability.

The relative slope stability risk at the Forestwide level for Alternative B-1 is projected to be about one-half of one percent. This was calculated using factor-of-safety values supplemented by field observations over time as to the tendency of individual soils to slide or slump naturally or when disturbed by various management activities. It represents a ratio of acres proposed for vegetation management to acres recognized as having higher stability risks. These values are based on the "incremental risk" associated with projected vegetation management and road construction activities in support of an alternative. This is in addition to the background risk that may exist, the alternative implemented, or the land management activities conducted. A relative risk of less than 10 percent is rated as Low, 10-30 percent is Moderate or Medium, and greater than 30 percent is Severe. The most accurate scrutiny, evaluation, and estimation of stability risks can be made only at the project level, however.

Water Quantity/Water Use

The effects of changes in water yield for Alternative B-1 are shown in Table 3 - 12. These water yields are expressed as the percentage increase over natural water yields and range from 0.09 to 0.24 percent. Water yield varies widely by time of year, intensity, and duration of storms, antecedent moisture conditions, as well as the timing of concentration of contributing flows. Water yield increases similar to those in Alternative B-1, less than two percent, would probably go undetected. Localized increases could be larger than those reported in Table 3 - 12, but such effects would be more appropriately addressed at the site-specific project level.

Based on local knowledge and field observations, stream channels within the Forest are usually stable and capable of handling the small increases in flow that are projected for this alternative

without causing channel erosion. This is particularly true if the increases in water yield occur during summer low-flow periods.

Table 3 - 12 also shows how the projected increases in water yield for Alternative B-1 compares with the 1995 water use data by Management Area. As the table shows, the projected increases are relatively small (< 2 mg/d), especially considering that supply far exceeds demand on most occasions. Any increases in summer low-flow, if detectible, would be a benefit to local water users and instream uses. However, it is unlikely that actions in this alternative would have an effect on local water supplies or aquatic biota.

Table 3 - 12. Water yield and water use increases by Management Area for Alternative B-1.

MANAGEMENT AREA	% Water Yield Increase	Water Yield Increase (millions of gallons per day)	Total Water Use (millions of gallons per day)
Licking River	0.09	0.42	37.11
Middle Kentucky River	0.09	0.44	15.86
Upper Kentucky River	0.09	0.45	7.92
Upper Cumberland River	0.24	1.16	424.31

CUMULATIVE EFFECTS

Erosion and Sedimentation

As shown in Figure 3 - 4, the percentage of stream sediment increase above existing conditions from erosion of both private and National Forest System land would range from 0.02 to 1.32 percent. Given the natural variability associated with stream sedimentation, cumulative changes of this magnitude would likely go undetected on a 5th level watershed and would not change the Watershed Condition Rank for any of the watersheds. The Analysis revealed that 25 watersheds are in Excellent condition, two are in Average condition.

The risk of additional cumulative effects associated with erosion from National Forest System lands would be low. Implementation of appropriate management Standards would serve to minimize soil loss as well as safeguard long-term soil productivity and water quality. Successful revegetation of disturbed soils can be achieved within two or three growing seasons, returning erosion rates to pre-disturbance levels.

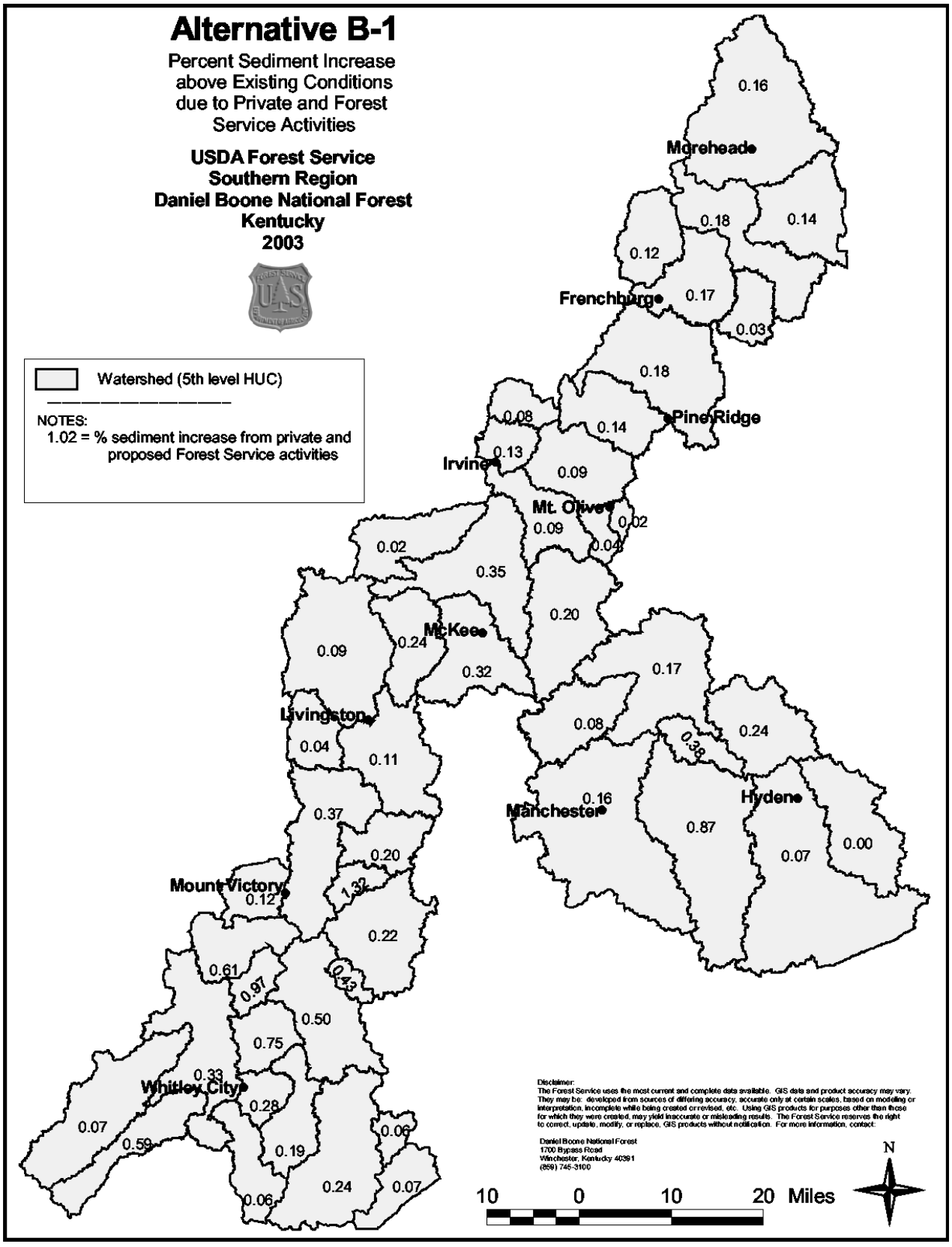

Figure 3 - 4. Cumulative stream sediment increases by watershed.

OTHER EFFECTS

Long-term Soil Productivity/Nutrient Cycling

Based on analysis of proposed management and its potential effects on the soils resource, implementation of Alternative B-1, excluding roads, which are dedicated to long-term use and Forest management, would have a small effect on long-term soil productivity. The resulting loss in productive potential would be less than five percent. Many of the projected impacts to soils are unavoidable, however. They represent a commitment of soil resources necessary to support proposed Forest management goals. Utilization of some acreage is necessary to develop the infrastructure needed for sustainable production of goods and services.

In general, soil productivity across the DBNF ranges from stable to improving. Only localized declines in soil productivity are occurring. Erosion, displacement, and compaction caused by construction of roads, log landings, drilling pads/pits, etc., are responsible for most decreases in soil productivity on the forest. Overall, these reductions are low. Total estimated long-term soil impacts of 3,037 acres or about 0.4 of one percent of the Forest has been predicted as occurring under Alternative B-1 in the first decade.

ALTERNATIVES C, C-1, AND D

DIRECT AND INDIRECT EFFECTS

Erosion and Sedimentation

Accelerated erosion is an unavoidable consequence of road construction, timber harvest, and to a lesser degree, recreational uses such as off-highway vehicle trails and heavily used dispersed camping sites.

Implementing the mix of management prescriptions in the 1985 Plan that disturbs soils would likely accelerate erosion and sedimentation rates. These three alternatives would cause about the same level of soil disturbance, based on the acreage planned for vegetation management, site preparation, prescribed fire, blade constructed fire lines, recreation trails and road construction. Alternatives C, C-1, and D would create elevated erosion potential on 13,305, 13,340 and 13,375 acres, respectively, for the first decade of the 2004 Forest Plan.

Soil Displacement

Removal of surface soil layers, rich in nutrients as well as the numbers and diversity of soil microorganisms, can have a strong adverse influence on soil productivity. Under Alternatives C, C-1, and D they would subject an estimated 6,947 acres to some level of soil displacement.

Soil Compaction

Soil compaction results in soil conditions less favorable for plant growth. Soil compaction can occur on all of the soils developing on the forest with repeated passage of heavy equipment, OHVs and foot traffic. The area disturbed and compacted increases with each succeeding harvest entry, commercial thinning, and final harvest followed by mechanical site preparation.

Over the first 10 years of the 2004 Forest Plan, compaction generated by operation of heavy machinery while harvesting timber, doing mechanical site preparation, construction of roads, drill pads, fire lines, etc., would likely have an adverse effect on about 9,990 acres.

Fire

The effects of prescribed fire on soil productivity can vary with soil conditions (e.g., antecedent soil moisture), soil properties and qualities, as well as the type, extent, intensity, and duration of the burn plus fuel loads and conditions. Where fire is of such duration and intensity that it affects soil biota, structure, organic matter, and fertility, it may potentially trigger accelerated erosion and loss of soil nutrients. Suspended solids, sediments and dissolved salts in streamflow would increase nutrient enrichment.

An estimated two percent of all acres burned using prescribed fire would be severely burned. A severe burn consumes all organic matter on the soil surface and within the upper half-inch of the mineral soil, visibly altering soil structure and/or color. Hydrologic condition and function of soils and their productive potential are harmed in the short-term.

Of the acreage likely to be treated with prescribed fire during the first decade, only about 6,364 acres would be severely affected.

Slope Stability

When soils are displaced and/or buried from slope failures, natural or human caused, the original site becomes less productive. Removal of tree cover from soils can accelerate the occurrence of landslides due to loss of root strength in soils prone to failure. Furthermore, changes in infiltration and permeability rates associated with timber harvest and road building affect soil stability.

Relative slope stability risks, at the Forestwide scale for Alternatives C, C-1, and D are projected to be 6.3 percent. These risks were based on calculated factor-of-safety values, supplemented with recorded and general field observations over time as to the tendency of individual soils to slide or slump both naturally and where disturbed by various management actions. The most accurate scrutiny, evaluation, and estimation of stability risks occur only at the project-level scale.

The relative risk ratings used to derive this conclusion are Low, less than 10 percent risk; Moderate or Medium, 10-30 percent risk; and Severe, greater than a 30 percent risk. This represents a ratio of acres proposed for vegetation management to acres recognized as having higher stability risks. These values are considered “incremental risk” associated with projected vegetation management and road construction activities in support of each alternative. This is in addition to background risks that may exist with slope stability independently of implementation of each alternative or absence of land management activities.

Water Quantity/Water Use

The effects of the changes in water yield for Alternatives C, C-1, and D are shown in Table 3 - 13. The water yields are expressed as the percentage of increase over natural water yields and range from 0.45 to 1.36 percent. Water yield is extremely variable in the relation to the time of year, intensity, and duration of storms, antecedent moisture conditions, as well as the timing of concentration of contributing flows. Water yield increases similar to those in Alternatives C, C-1 and

D of less than two percent would probably go undetected. Localized increases could be larger than those reported in Table 3 - 13. These effects are more appropriately addressed at the site-specific project level.

Based on local knowledge and field observations, stream channels within the Forest are usually stable and capable of handling the small increases in flow that are projected for these alternative without causing channel erosion. This is particularly true if the increases in water yield occur during summer low-flow periods.

Table 3 - 13 also shows how the projected increases in water yield for Alternatives C, C-1 and D compares with the 1995 water use data by Management Area. As the table shows the projected increases are relatively small (< 7 mg/d) especially considering supply far exceeds demand on most occasions. Any increases in summer low-flow, if detectible, would be a benefit to local water users as well as instream uses. However, it is unlikely that actions in these alternatives would have an effect on local water supplies or aquatic biota.

Table 3 - 13. Water yield and water use increases by Management Area for Alternatives C, C-1, and D.

MANAGEMENT AREA	% Water Yield Increase	Water Yield Increase (millions of gallons per day)	Total Water Use (millions of gallons per day)
Licking River	0.09	2.81	37.11
Middle Kentucky River	0.09	2.20	15.86
Upper Kentucky River	0.09	3.57	7.92
Upper Cumberland River	0.24	6.66	424.31

CUMULATIVE EFFECTS

Erosion and Sedimentation

Figure 3 - 5 shows that the percentage of stream sediment increase above existing conditions from the combination of private and Forest Service erosion ranges from 0.02 to 26.00 percent. Given the natural variability associated with stream sedimentation, it is unlikely that cumulative changes of this magnitude will be detectable on a 5th level watershed scale or will change the Watershed Condition Rank for any of the watersheds. The Analysis revealed that 25 watersheds are in Excellent condition, two are in Average condition.

On Forest Service System lands there is a low risk of adding to the cumulative effects associated with erosion processes. Implementation of appropriate mitigating measures or management standards would serve to minimize soil loss rates as necessary to safeguard long-term soil productivity and water quality. Successful revegetation of disturbed soils normally is achieved within two or three growing seasons, thereby returning erosion rates to pre-disturbance levels.

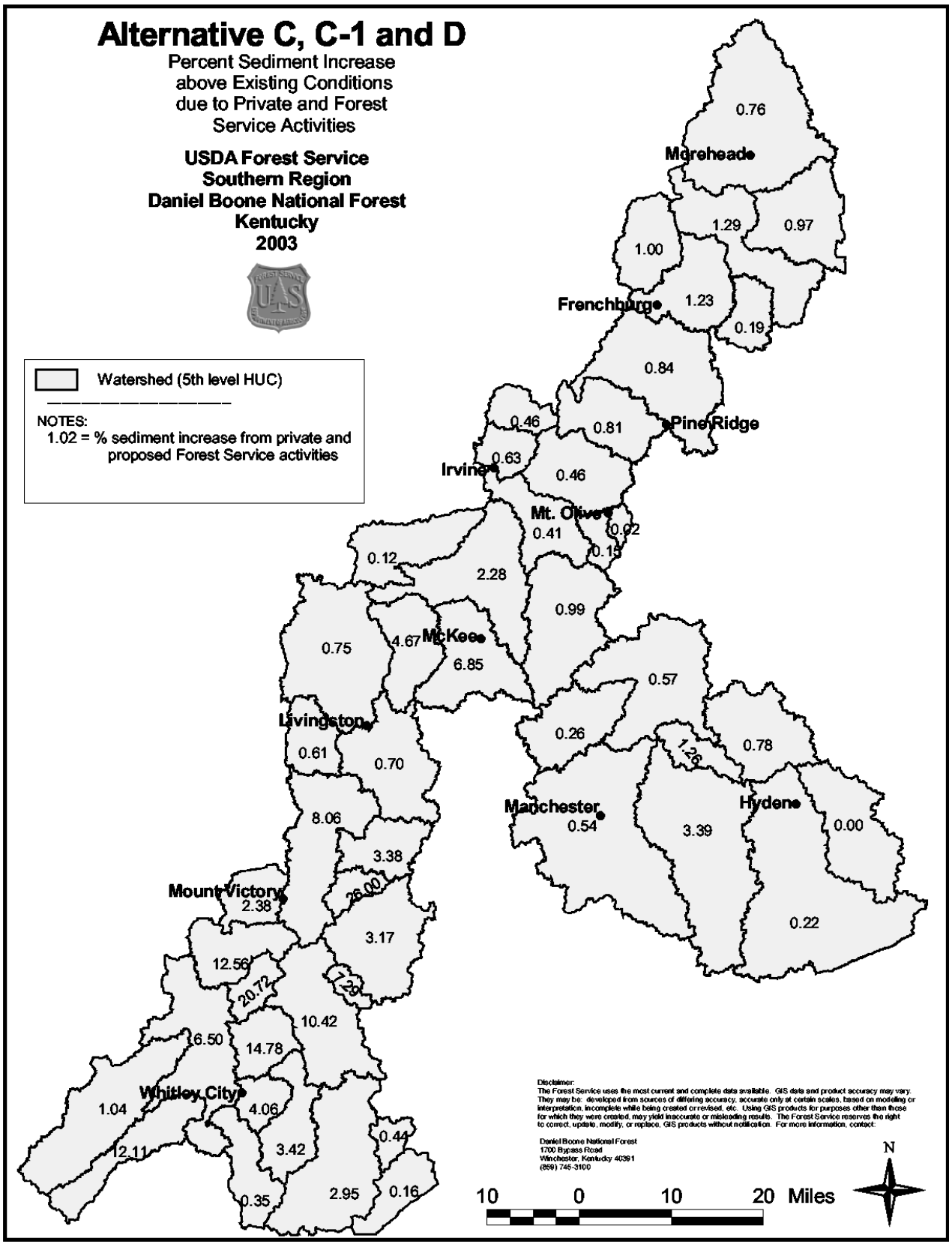

Figure 3 - 5. Cumulative stream sediment increases by watershed.

OTHER EFFECTS

Long-term Soil Productivity/Nutrient Cycling

Soil productivity is the natural capability of the soil to sustain the growth of plants and plant communities over time. In addition, this includes maintenance of soil properties and qualities for protection of water quality and forest health as well. Therefore, since most Forest uses ultimately depend on a productive soil resource, maintenance and enhancement of long-term soil productivity is a basic requirement of Forest management.

Based on analysis of proposed management and potential effects on the soils resource, implementation of alternatives C, C-1, or D (excluding roads, which are dedicated to long-term use and management of the forest) would have a moderate effect on long-term productivity, resulting in a 5 to 15 percent reduction in productive potential. Many of the projected impacts to soils are unavoidable, however. They represent a commitment of soil resources necessary to support proposed Forest management goals. Utilization of some acreage is necessary to develop the infrastructure needed for sustainable production of goods and services from the Forest.

In general, soil productivity across the forest is judged to be stable to improving. Essentially, only localized declines in soil productivity are occurring. These losses are directly associated with erosion, soil displacement, and increases in soil density from compaction, caused by construction of roads, log landings, drilling pads/pits, etc. Overall, these reductions are low across the forest.

Total estimated long-term soil impacts for Alternatives C, C-1, and D are 9,796; 9,841; and 9,884 acres respectively or about 1.4 percent of the Forest within the first decade.

ALTERNATIVE E-1

Direct and Indirect Effects Erosion and Sedimentation

Accelerated erosion is an unavoidable consequence of road construction, timber harvest, and to a lesser degree, recreational uses such as off-highway vehicle trails and heavily used dispersed camping sites.

Implementing the mix of management prescriptions in the 1985 Plan that would disturb soils, is projected to generate an increased risk of accelerating erosion and sedimentation rates on 30,543 acres for the first decade of the 2004 Forest Plan.

Soil Displacement

Removal of surface soil layers, rich in nutrients and numbers and diversity of soil microorganisms, can have a strong adverse influence on soil productivity. Under Alternative E-1 an estimated 8,285 acres would be subject to some level of soil displacement in the first decade.

Soil Compaction

Soil compaction results in soil conditions less favorable for plant growth. Soil compaction can occur on all of the soils developing on the forest with repeated passage of heavy equipment, OHVs and

foot traffic. The area disturbed and compacted increases with each succeeding harvest entry, commercial thinning, and final harvest followed by mechanical site preparation.

Over the first 10 years of the 2004 Forest Plan, compaction generated by operation of heavy machinery while harvesting timber, doing mechanical site preparation, construction of roads, drill pads, fire lines, etc., would likely have an adverse effect on about 25,022 acres.

Fire

The effects of prescribed fire on soil productivity can vary with soil conditions (e.g., antecedent soil moisture), soil properties and qualities, as well as the type, extent, intensity, and duration of the burn plus fuel loads and conditions. Where fire is of such duration and intensity that it affects soil biota, structure, organic matter, and fertility, it may potentially trigger accelerated erosion and loss of soil nutrients. Suspended solids, sediments and dissolved salts in streamflow would increase nutrient enrichment.

For analysis purposes, a projected three percent of all acres burned using prescribed fire techniques would be severely burned. A severe burn consumes all organic matter on the soil surface and within the upper half-inch of the mineral soil, visibly altering soil structure and/or color. Hydrologic condition and function of soils and their productive potential are harmed in the short-term. The prescribed fire program under Alternative E-1 could potentially severely burn about 770 acres.

Slope Stability

When soils are displaced and/or buried from slope failures, natural or human caused, the original site becomes less productive. Removal of tree cover from soils can accelerate the occurrence of landslides due to loss of root strength in soils prone to failure. Furthermore, changes in infiltration and permeability rates associated with timber harvest and road building affect soil stability.

Relative slope stability risks, at the Forestwide scale for Alternative E-1 is projected to be 13.4 percent. These risks were based on calculated factor-of-safety values, supplemented with recorded and general field observations over time as to the tendency of individual soils to slide or slump naturally or when disturbed by various management actions. The most accurate scrutiny, evaluation, and estimation of stability risks occur only at the project-level scale.

The relative risk ratings used to derive this conclusion are Low, less than 10 percent risk; Moderate or Medium, 10-30 percent risk; and Severe, greater than a 30 percent risk. This represents a ratio of acres proposed for vegetation management to acres recognized as having higher stability risks. These values are considered “incremental risk” associated with projected vegetation management and road construction activities in support of each alternative. This is in addition to background risks that may exist with slope stability independently of implementation of each alternative or absence of land management activities.

Water Quantity/Water Use

The effects of the changes in water yield for Alternative E-1 are shown in Table 3 - 14. The water yields are expressed as the percentage of increase over natural water yields and range from 0.62 to 1.50 percent. Water yield is extremely variable in the relation to the time of year, intensity and duration of storms, antecedent moisture conditions, as well as the timing of concentration of

contributing flows. Water yield increases similar to those in Alternative E-1 that are less than two percent would probably go undetected. Localized increases could be larger than those reported in Table 3 - 14. These effects are more appropriately addressed at the site-specific project level.

Based on local knowledge and field observations, stream channels within the Forest are usually stable and capable of handling the small increases in flow that are projected for this alternative without causing channel erosion. This is particularly true if the increases in water yield occur during summer low-flow periods.

Table 3 - 14 also shows how the projected increases in water yield for Alternative E-1 compare with the 1995 water use data by Management Area. As the table shows the projected increases are relatively small (< 8 mg/d) especially considering supply far exceeds demand on most occasions. Any increases in summer low-flow, if detectible, would be a benefit to local water users as well as instream uses. However, it is unlikely that actions in this alternative would have an effect on local water supplies or aquatic biota.

Table 3 - 14. Water yield and water use increases by Management Area for Alternative E-1.

Management Area	% Water Yield Increase	Water Yield Increase (millions of gallons per day)	Total Water Use (millions of gallons per day)
Licking River	0.81	3.95	37.11
Middle Kentucky River	0.62	3.03	15.86
Upper Kentucky River	0.83	4.06	7.92
Upper Cumberland River	1.50	7.34	424.31

CUMULATIVE EFFECTS

Erosion and Sedimentation

Figure 3 - 6 shows that the percentage of stream sediment increase from the combination of private and Forest Service erosion would range from 0.02 to 26.34 percent. Given the natural variability associated with stream sedimentation it is unlikely that cumulative changes of this magnitude will be detectable on a 5th level watershed scale or will change the Watershed Condition Rank for any of the watersheds. The Analysis revealed that 25 watersheds are in Excellent condition and three are in Average condition.

On Forest Service System lands there is a low risk of adding to the cumulative effects associated with erosion processes. Implementation of appropriate mitigating measures or management standards will serve to minimize soil loss rates as necessary to safeguard long-term soil productivity and water quality. Successful revegetation of disturbed soils normally is achieved within two or three growing seasons, thereby returning erosion rates to pre-disturbance levels.

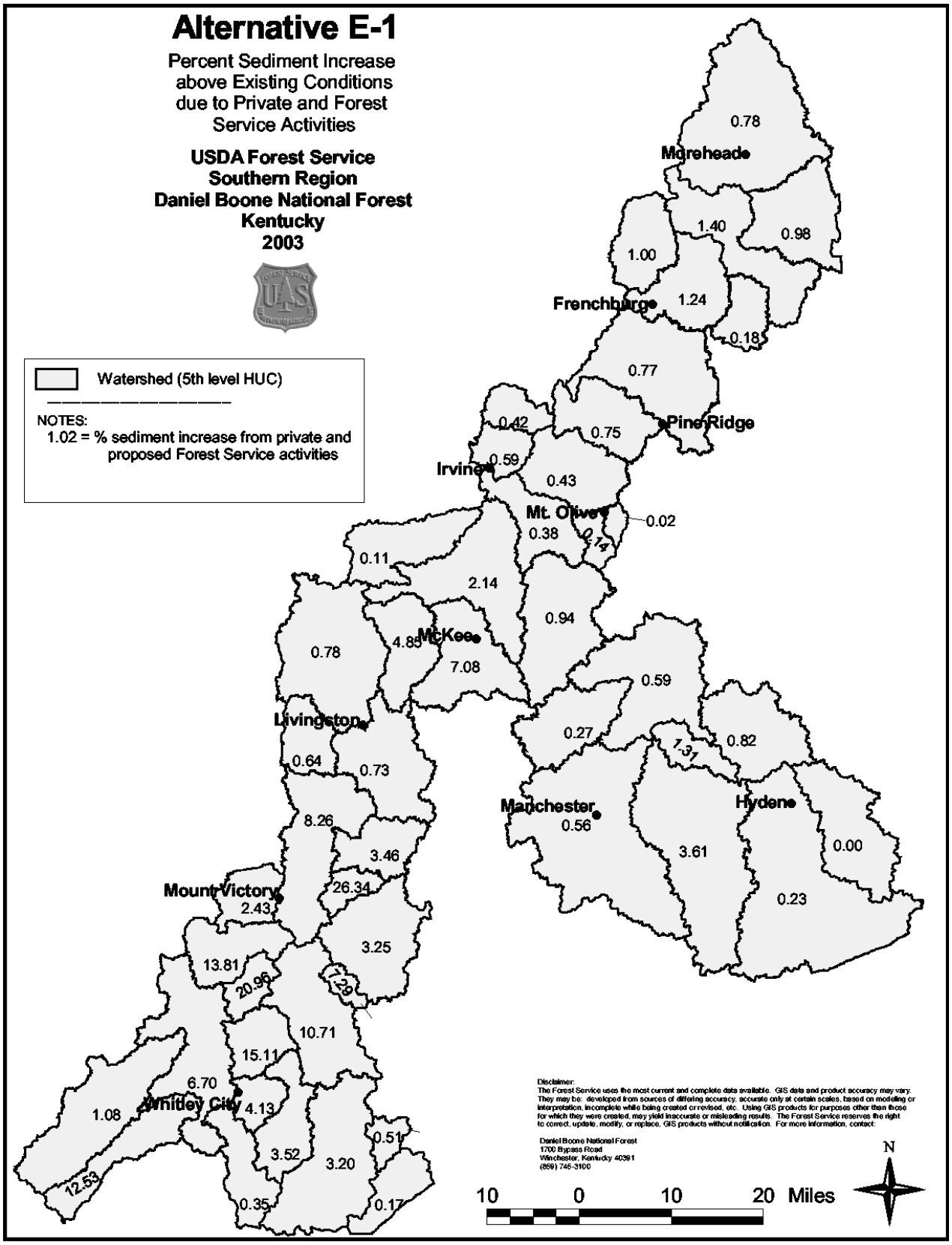

Figure 3 - 6. Cumulative stream sediment increases by watershed.

OTHER EFFECTS

Long-term Soil Productivity/Nutrient Cycling

Soil productivity is the natural capability of the soil to sustain the growth of plants and plant communities over time. In addition, this includes maintenance of soil properties and qualities for protection of water quality and forest health as well. Since most forest uses ultimately depend on a productive soil resource, maintenance and enhancement of long-term soil productivity is a basic requirement of Forest management.

Based on analysis of proposed management and potential effects on the soils resource, implementation of Alternative E-1, excluding roads, which are dedicated to long-term use and management of the Forest will have a moderate effect on long-term productivity resulting in a 5 to 15 percent reduction in productive potential. Many of the projected impacts to soils are unavoidable. They represent a commitment of soil resources necessary to support proposed Forest management goals. Utilization of some acreage is necessary to develop the infrastructure needed for sustainable production of goods and services from the Forest.

In general, soil productivity across the forest is judged to be stable to improving. Essentially, only localized declines in soil productivity are occurring, where directly associated with increasing loss of soil from erosion, soil displacement, and increases in soil density from compaction, resulting from construction of roads, log landings, drilling pads/pits, etc., which all increase the amount of soil loss or total soil resource commitment. Overall, these reductions are low across the forest. Total estimated long-term soil impacts of about 11,571 acres, or about 1.7 percent of the Forest, has been predicted as occurring under Alternative E-1 in the first decade.

MINERALS

Affected Environment

BACKGROUND

Minerals are an important aspect of Kentucky's resources and contribute greatly to the local economy while helping meet both state and national energy needs. The Daniel Boone National Forest plays an important role in eastern Kentucky's mineral development as manager of 700,000 acres of National Forest System land. Minerals management differs significantly from management of other Forest resources such as timber or recreation opportunities.

First, minerals can be difficult to find and inventory. Secondly, development of mineral resources is very dependant on market conditions, local as well as national and global. Such uncertainties complicate out-year project planning. Still, the project planner must attempt to analyze the potential for development on available property and its potential environmental impacts. Development usually occurs near location of the resource. Determination of areas appropriate for mineral leasing must be made in light of such contingencies.

Also, the U.S. economy is very dependent on minerals, which are non-renewable resources. Mineral resources on the DBNF include limestone and building stone, petroleum, natural gas, and coal.

Legal and Administrative Framework

Statutory and regulatory direction separates mineral resources on federally owned lands into three categories: locatable, leasable, and salable. Statutes, regulations, and executive orders guide Forest Service policy governing the exploration and development of mineral resources on National Forest System lands.

Lands Statutorily Unavailable For Mineral Leasing or Permit

- Subject to valid existing rights, the minerals in lands designated under the Wilderness Act of 1964, are withdrawn from all forms of disposition under all laws pertaining to mineral leasing. The Daniel Boone National Forest has two congressionally designated wildernesses, the Clifty Wilderness on the Stanton Ranger District and the Beaver Creek Wilderness area on the Somerset Ranger District. In these areas, 17,437 acres are statutorily withdrawn from leasing. Currently, there are no issued federal mineral leases or permits within the Forest's two designated wilderness areas.
- Subject to valid existing rights, the minerals in federal lands, which constitute the bed or bank, or are situated within ¼ mile of the bank of any river designated a "Wild River" under this Wild and Scenic Rivers Act of 1968, are withdrawn from operation of the mineral leasing laws. This restriction does not apply to those segments of a Wild and Scenic River that are designated as "scenic" or "recreational."

Development along portions of two streams within the DBNF is subject to restrictions of the Wild and Scenic Rivers Act. The Red River was designated for inclusion in the Wild and Scenic River system in 1988, and a segment of Marsh Creek is eligible for designation. Most National Forest System land along the 4.1-mile stretch of the Red River classified as "wild" lies within the

boundaries of the Clifty Wilderness. As such, it is already unavailable for lease under the Wilderness Act. Approximately 83.40 acres along the Red River that is subject to Wild and Scenic Rivers Act restrictions lie outside the wilderness boundary. These lands are statutorily withdrawn from mineral leasing under the Wild and Scenic Rivers Act. The 7-mile segment of Marsh Creek that is eligible for designation as a National Wild and Scenic River will be managed as a "wild" stream until a permanent determination is made.

Leasable Minerals

National Forest System lands are generally available for exploration and mining unless specifically precluded by an act of Congress or other formal withdrawal. Which mineral-leasing act applies depends on the type of lands and minerals involved. The 2004 Forest Plan identifies those areas, which are available and unavailable for energy and non-energy exploration and leasing. For non-energy leasable minerals, public scoping and a site-specific analysis are completed by the Forest Service upon BLM's receipt of a permit or lease application. This is done prior to issuance of the permit or lease. For energy leasable minerals, the 2004 Forest Plan makes both the land availability decision, and the decision to lease certain available federal minerals. Lands where the minerals are statutorily withdrawn from leasing are identified in the Forest Plan. Public scoping and site-specific analysis of energy leasable mineral development will be completed when a Notice of Staking (NOS), or an Application for Permit to Drill (APD), is received by the BLM and the Forest Service.

Leasable Minerals (Oil & Gas. Coal) – With passage of the 1920 Mineral Leasing Act, Congress established a program to provide for oil, gas and coal development on federal lands, including National Forests. This Act authorizes the Secretary of the Interior to issue leases for the disposal of certain minerals (including coal, phosphate, sodium, potassium, oil, oil shale, gilsonite, and gas). The Mineral Leasing Act for Acquired Lands of 1947 extends these mineral leasing provisions to acquired National Forest System lands but requires the consent of the Secretary of Agriculture prior to leasing. The purpose of this Act is "to promote the mining of coal, phosphate, sodium, potassium, oil, oil shale, gas, and sulphur on lands acquired by the United States." All National Forest System lands on the DBNF are "acquired." The Surface Mining Control and Reclamation Act of 1977 prohibits surface (strip) mining of coal on any federal lands within the boundaries of any National Forest east of the 100th meridian. Therefore, deposits of coal on the DBNF may be mined only by underground methods.

The Energy Security Act of 1980 directs the Secretary of Agriculture to process applications for leases and permits to explore, drill, and develop energy resources on National Forest System lands, notwithstanding the current status of any Land and Resource Management Plan (Forest Plan). Federal oil and gas leases on the DBNF since 1980 were issued in accordance with this congressional direction as well as public demand for energy resource development. The Act will also apply to 2004 Forest Plan. With passage of the Federal Onshore Oil and Gas Leasing Reform Act of 1987, Congress again recognized the Forest Service's role in the leasing and administration of surface operations during oil and gas development. The implementing regulations for this Act (36 CFR 22E) provide the basis for the analysis of alternatives and decisions on federal oil and gas leasing in the 2004 Forest Plan.

Executive Order 13212 (Actions to Expedite Energy-Related Projects) of 2001 states "executive departments and agencies shall take appropriate actions, to the extent consistent with applicable law, to expedite projects that will increase the production, transmission, or conservation of energy." The

Executive Order 13212 requires that: "For energy-related projects, agencies shall expedite their review of permits or take other actions as necessary to accelerate the completion of such projects, while maintaining safety, public health, and environmental protections."

The federal oil and gas leasing program on National Forests helps supply the nation with critical energy minerals and provides a source of revenue to local, state and federal governments. Oil and gas leases are issued primarily through a competitive bid process, generating revenue from bonus bids (not less than $2.00 per acre) as well as annual rental fees (not less than $1.50 per acre). If a producing well is drilled which produces oil and gas from lands covered by a federal lease, the federal government receives a 12.5 percent royalty based on actual production. In some instances, the normal 12.5 percent royalty could be higher. An increase in the royalty rate is a condition of re-instatement of a federal lease if rental was not paid in a timely manner. The royalty rate could be lower if the well meets the very narrow guidelines under the federal Royalty Reduction Act. The Dept. of Interior's Minerals Management Service (MMS) collects all minerals revenues generated from federal leases. MMS then distributes 25 percent of mineral receipts acquired from leases on the DBNF to the state of Kentucky for allocation to the counties.

The 2004 Forest Plan makes two decisions related to minerals: 1) availability of lands for future leasing, and 2) consent to lease the available lands, subject to standard lease terms, or subject to additional constraints (stipulations) as required by a specific prescription area. The Forest Plan analyzes areas of the Forest with leasing interest or mineral potential using the "Reasonably Foreseeable Development Scenario" developed with the assistance of BLM geologists. This study looked at the long-term (10 years) potential for oil and gas development in the study area and projected the number of wells likely to be drilled during over 10 years. Under the 2004 Forest Plan, the BLM will be able to issue oil and gas leases in areas where the Plan makes both the availability and the consent decision. Because the availability and consent decisions are made in the Plan, environmental analysis and documentation for federal oil and gas is more detailed than for other leasable minerals.

Once an oil and gas lease is issued, the National Environmental Protection Act requires a second round of review before the lessee may stake the drill site, occupy the surface, or begin drilling. The Order outlines the necessary requirements for the approval of all proposed exploratory, development, and service wells. The lessee must apply to the BLM for an Application for Permit to Drill (APD) per direction in Onshore Oil and Gas Order #1. The APD contains two parts: the Surface Use Plan of Operations (SUPO), and the technical, "downhole" Drilling Plan. The Forest Service, in cooperation with the BLM, completes an environmental analysis, including public involvement, of the proposed roads, wells, and any other ground disturbance activities proposed in the SUPO portion of the APD. The BLM is responsible for the review and approval of the drilling plan. After the environmental analysis and public involvement, the Forest Service will decide whether to approve the surface use plan of operations portion of the APD. If the proposed location has been amended to accommodate other resource needs, the location must be approved. The specific Conditions of Approval (COA) must also be decided. The reclamation plan is critical part SUPO approval. Each operator proposing to develop federal minerals must post a bond with the BLM to insure compliance with operating and reclamation requirements.

Under the terms of a federal lease, the lessee is granted the exclusive right to drill for, mine, extract, remove, and dispose of all the leased resources, along with the right to build and maintain necessary improvements on the leasehold. Standard lease terms (SLTs) for federal oil and gas leases require

operators to minimize adverse impacts to the land, air, and water as well as cultural, biological, visual, and other resources. STLs also require minimized adverse impact to other land uses or users. Federal environmental protection laws such as the Clean Air Act, Clean Water Act, Endangered Species Act, and Historic Preservation Act apply to all proposed activities.

In addition, based on prescription area direction in the Forest Plan, leases may be issued subject to stipulations that modify standard lease rights and are attached to and made a part of the lease. Conditions or restrictions in these stipulations are considered consistent with the lease rights granted, provided that they do not require relocation of proposed operations by more than 200 meters, require that the operations be sited off the leasehold, or prohibit new surface disturbing operations for a period in excess of 60 days in any lease year.

The three nationally approved stipulation forms include:

- No Surface Occupancy (NSO) – Used when surface occupancy of certain lands is prohibited.
- Timing / Season – Used to prohibit surface occupancy of certain lands during specific times, such as for protection during nesting or calving season.
- Controlled Surface Use (CSU) – Used when restrictions will apply to occupancy, such as requiring additional mitigation to resolve potential conflicting uses, or to meet visual quality objectives.

A lease may also be issued subject to a lease notice (LN). A notice does not contain any new restrictions. It simply puts the lessee on "notice" that his operations must be in compliance with the applicable statute(s), such as the Endangered Species Act, if applicable at the time surface occupancy is proposed.

In addition to the two lease stipulations that may be required, there are two LNs that are used consistently:

- LN #3, which indicates that all or part of the leased lands may contain animal or plant species classified under the Endangered Species Act. All leases and permits issued will be subject to this lease notice.
- LN #4, which indicates that all or part of the leased lands may be classified as wetlands, floodplain, or riparian areas that will require special protection. All leases and permits issued where these areas are present will require this notice.

Issued leases are reviewed locally by the Forest Service to assure compliance with two basic requirements. Under Bureau of Land Management rules, an entity holding a coal lease cannot qualify for an oil and gas lease unless the coal lease is operating properly. In addition, leases must also comply with all rules and regulations issued by the Secretary of Agriculture when not inconsistent with the rights granted in the lease.

A lessee may request a modification waiver, or one-time exception of an NSO stipulation, or any other stipulation. The Forest Service may authorize the BLM to grant the change if: 1) the change is consistent with federal law and the local Forest Plan, 2) management objectives which led to the stipulation can be met following the change, and 3) the environmental impact of the change is acceptable. If the change substantially modifies the terms of the lease, public notice must be given at

least 30 days before the results of an environmental analysis are approved (Federal Onshore Oil and Gas Leasing Reform Act of 1987).

In all cases where the minerals are privately owned, the Forest Service must obtain the best surface protection possible using the terms and the deed severing the subsurface from the surface estate, applicable state and federal laws (i.e. Endangered Species Act), and cooperation and negotiations with the operator.

There are 65 Federal oil and gas leases issued on the Daniel Boone National Forest covering 58,988.24 acres. There are currently 42 producing wells from these leases.

Salable Minerals

The Mineral Materials Act of 1947 authorized the disposal of mineral and vegetative materials through a sale system on U.S. public lands. The act also provides for free use of these materials by federal or state agencies, municipalities, or nonprofit associations as long as those materials are not for commercial, industrial, or resale purposes. The act was amended by the Multiple Use Mining Act of 1955, which defines "common variety mineral materials" and distinguished them from rare varieties (uncommon variety mineral material). Uncommon varieties of mineral materials may be locatable in certain states under the Mining Law of 1872.

Mineral materials or "common variety" minerals are commodities having a low value per ton, including sand, gravel, crushed stone, riprap, clay, and fill dirt. These materials are used in road construction, landscaping, and as building materials. They can be sold to individuals or companies through negotiated or competitive bidding or given as free use to public agencies (e.g., county and state highway departments) for public purpose use. Any sale of mineral materials must be made at no less than fair market value as determined by an appraisal. Sale of mineral materials is at the discretion of the local Forest, and it can choose not to do so as determined by the District Ranger. Currently there is one lease for limestone on the DBNF.

MINERAL OWNERSHIP

Mineral ownership on the DBNF is very inter-mixed, resembling the mosaic pattern of surface ownership within the proclamation boundary. Minerals underlying National Forest System land may be federally owned, "reserved" by the previous surface owners, or "outstanding" in third parties.

Federal Minerals

Mineral rights are those that have been acquired by the federal government through purchase, exchange, or donation.

Private Mineral Rights (Reserved and Outstanding Mineral Rights)

The authority for the administration of mineral reservations is contained in 36 CFR 251.15 or previously issued Secretary of Agriculture's rules and regulations governing mineral rights reserved in conveyances to the United States. Rules and regulations governing mineral rights are normally incorporated into deeds that that transfer surface ownership to the federal government. Forest

Service direction for the administration of reserved and outstanding rights is found in Chapter 2830 of Forest Service Manual 2800.

Private-mineral rights are exercised for both exploration and development of mineral resources in various locations on the DBNF. This section discusses how the Forest Service manages mineral exploration and development of Reserved and Outstanding Rights (ROR) under federally owned surface. In recent years the DBNF has overseen plans of operations on federal surface for development of private oil and gas, underground coal mining, and mineral material development.

An important difference in the administration of ROR is that exercise of those rights is not a privilege, but a right owned by a private party. As such, the Forest Service has no role in leasing, and the BLM is not involved in approval of an Application for Permit to Drill (APD). Since there is no lease or permit, there is no contractual agreement to be met. Reserved mineral rights are subject to state laws and Secretary's Rules and Regulations, which were made part of the severance deed when the surface was purchased by the United States. The most common version of the Secretary's Rules and Regulations dates from 1911 and does not require a permit. Later versions (1937, 1938, 1939, 1947, 1950 and 1963) did require a permit. In cases of reserved mineral rights, the Forest Service will approve an operation permit. For outstanding minerals, a minerals operation plan will be negotiated. Even though a permit is not specifically required, the operator must still develop and submit a plan of operation for review by the Forest and recommendations.

The following discusses two interrelated potential effects relating to outstanding and reserved mineral rights on the DBNF: 1) The potential effects of the 2004 Forest Plan on the exercise of private mineral rights on NFS lands, and 2) The potential effects of private mineral rights operations on NFS lands.

Exploration or development of privately owned minerals on NFS lands is a private, not a federal decision. Tens of thousands of acres on the DBNF were acquired subject to reserved or outstanding private mineral rights. All Forest Plans remain subject to these existing private rights.

A Comptroller General's Report to Congress (GAO/RCED-84-101; July 26, 1984) found that the Forest Service in the eastern U.S. failed to provide Congress with information about private mineral rights and their potential effect on wilderness management. The General Accounting Office recommendation to the Secretary of Agriculture stated: "Because the Forest Service did not analyze the potential problems or costs associated with private mineral rights when it developed its 1979 wilderness recommendations, GAO recommends that the Secretary direct the Forest Service's southern and eastern regional offices to do this type of analysis when re-evaluating its wilderness recommendations. This analysis should include for each area consideration of private mineral development potential, the government's ability to control mineral development if it occurs, the need to acquire private mineral rights, and a range of acquisition costs."

These problems (management conflicts, litigation, and high costs) apply not only to Wilderness, but to 1) any highly restrictive designation that conflicts with exercise of private mineral rights on National Forest System lands, and 2) management prescriptions that impose severe restrictions on use of the surface or prohibit certain activities such as road construction or mining. Examples include Special Biological Areas, Wild and Scenic River designations, Wilderness Study Areas, or backcountry recreation areas.

The 5th Amendment to the U.S. Constitution provides that private property shall not be taken for public use without just compensation. Designations or prescriptions that prohibit mineral

development or are de facto prohibitions on mineral development can represent a "taking" of private property rights. For example, the time required to process private mineral activities under a Forest Plan's framework might result in unreasonable delays that amount to a "taking" of the mineral rights. Partial takings are also possible. Executive Order 12630, "Government Actions and Interference with Constitutionally Protected Property Rights," sighed in 1988, requires federal decision-makers to 1) evaluate carefully the effect of their administrative actions on private property rights, and 2) to show due regard to 5th amendment rights and to reduce the risk of undue or inadvertent burdens on the federal treasury. Concern about government "takings" of private property rights remains a national issue.

Since to access privately owned minerals is a right and not a privilege, it should be understood that restrictions and other stipulations regarding mineral development in the 2004 Forest Plan, such as prescription area standards and other restrictions on mineral development, apply only to federally owned minerals. Private mineral development will be managed by applicable state and federal laws, the deed of severance which separated the mineral estate from the surface estate, and the Secretary's of Agriculture's Rules and Regulations (if applicable).

Lands Involved

Of the 2,047,000 acres within the DBNF proclamation boundary, 693,726 are federally owned. Of the federally owned land, mineral rights for 406,341 acres are "reserved" by the previous surface owners or are "outstanding" in third parties. This division of ownership is illustrated in Table 3 - 15.

Table 3 - 15. Mineral ownership on the Daniel Boone National Forest.

Mineral Ownership	Acres	% of Total
100% of subsurface Privately Owned	406,341	59%
***100% of subsurface Federally Owned (NFS)**	235,696	34%
NFS has a partial interest in Minerals	51,689	7%
Total NFS surface ownership	693,726	

* Includes 168,000 acres of coal interest

SUPPLY AND DEMAND FOR MINERALS

Trends in the Demand for Minerals

The United States is one of the world's leaders in mineral consumption. Kentucky coal production far exceeds in-state coal use (Figure 3 - 7). Approximately 79 percent of Kentucky's coal production comes from the eastern portion of the state near the DBNF.[1] Nationally, petroleum resource imports have been on the increase for the past few decades. Figure 3 - 8 and Figure 3 - 9 shows that Kentucky's consumption of both petroleum and natural gas exceeds in-state production.

[1] Cole, L., E. Siegel, and L.W. Lyle. 2001. 2000 - 2001 State of Kentucky's Environment. Resource extraction section. Kentucky Environmental Quality Commission. Frankfort, KY. p. 135-155.

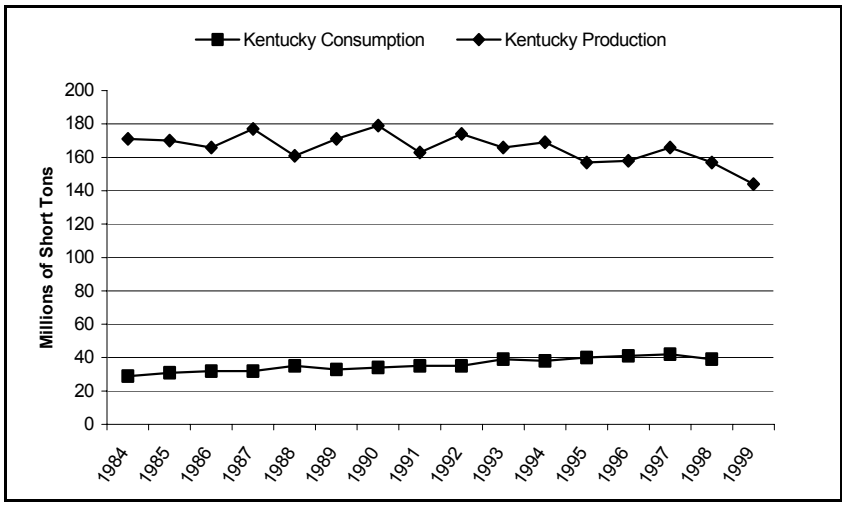

Figure 3 - 7. Coal Production/Consumption in Kentucky.

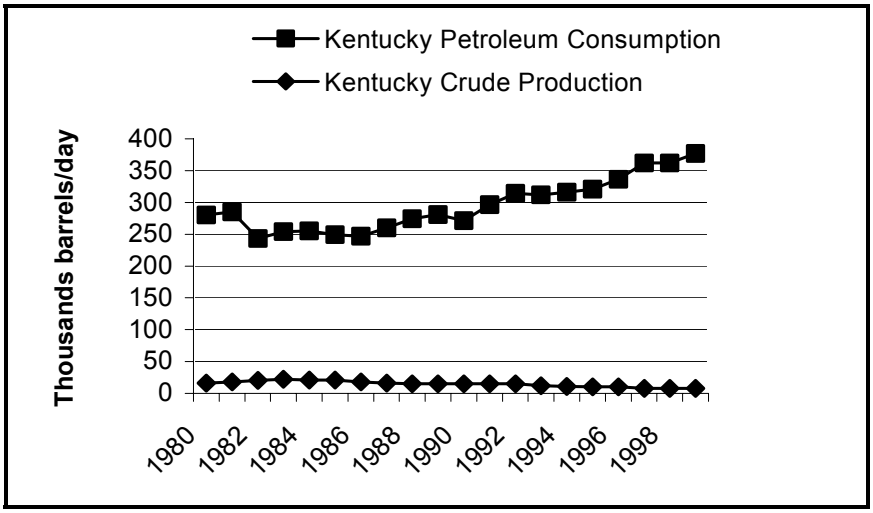

Figure 3 - 8. Petroleum Production/Consumption in Kentucky.

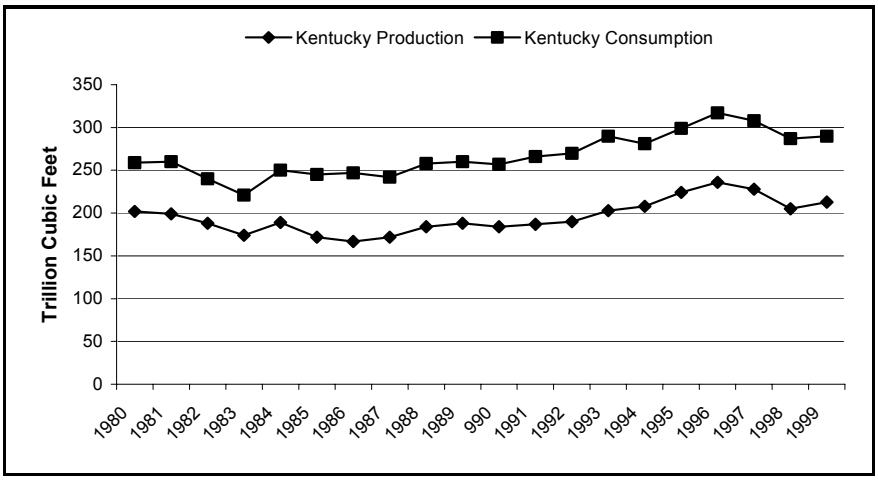

Figure 3 - 9. Natural Gas Production/Consumption in Kentucky.

Supply of Mineral Resources

The supply of petroleum and gas resources can be extended by more efficient use as well as conservation. While limited, Kentucky still has a vast supply of remaining coal resources. Many experts have varying opinions as to the future of mining in eastern Kentucky. It is clear however, that the potential for mining to occur on or near the DBNF during the next planning period is high. This is due to the interest in the development of coal that has increased over the last two to three years. This prediction was made over five years ago and new information could lower this estimate.

Comparison of Supply and Demand

Demand for mineral resources on the DBNF is likely to increase during the planning period. The gap between oil and gas consumption and production may continue to widen, and in the long-term, eastern Kentucky's coal resources will be depleted. National dependence on imports will likely increase unless new energy sources are developed.

Efforts to conserve minerals resources will depend on the level and cost of imports. Should import supplies become undependable or too costly, dependence on domestic production will increase.

Social, Economic and Environmental Implications

The trend of increasing consumption of coal, oil, and gas is illustrated in Figure 3 - 7 through Figure 3 - 9. Domestic production could be expected to increase in response to growing demand.

New job opportunities and higher incomes associated with increased domestic production should benefit local economies.

Increased production will also create environmental impacts. Some areas of concern include:

- Sedimentation from access and entry associated with coal development, subsidence form underground mining (no surface mining is allowed on the DBNF[2]), and acid mine drainage that may affect water quality and aquatic species.
- Sedimentation from access (road construction and use) and well pad construction associated with oil and gas development.
- The potential for ground water impacts if wells are abandoned and not adequately plugged.

Opportunities for Meeting the Nation's Minerals Needs

Domestic mineral needs can be met by increased imports and domestic production as well as new energy sources. Improving the business climate, encouraging minerals production on private lands, and facilitating minerals development on federal lands can enhance opportunities for increased exploration and development on the DBNF.

[2] Surface Mining Control and Reclamation Act of 1977

Constraints to Opportunities

The higher costs of new energy sources currently do not make them a feasible option for the near future. However, new developments may improve this option.

Uncertain profitability is not conducive for investment in mineral exploration and development.

Lack of information regarding mineral resources undermines confidence in the profitability of mineral development.

Forest Service staff shortages can inhibit development of federal lands on the DBNF.

Mineral Potential by Management Area

Figure 3 - 10 identifies the potential for coal, oil, and gas development on the DBNF. The rating categories are High, Medium and Low. The potential is essentially identical for each resource in the management areas, which is why they can be displayed on one map. Below is brief summary of the situation on the Forest for each resource.

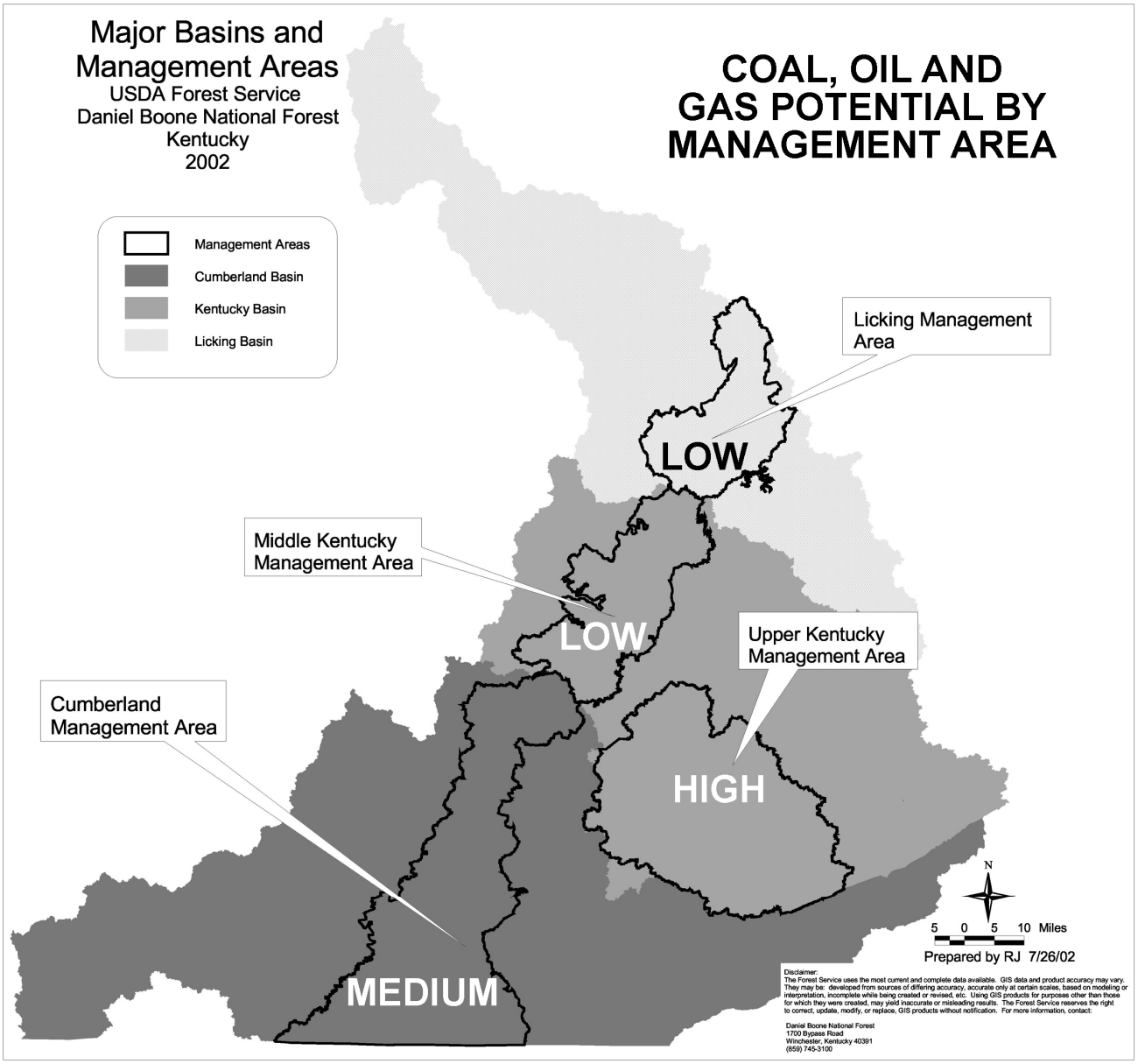

Figure 3 - 10. Mineral Potential by Management Area.

OIL AND GAS DEVELOPMENT

Oil and gas resources cannot be developed without surface disturbing activities such as constructing roads, laying pipeline, and pad location. Wells can be drilled on relatively small pads, however, and with good project administration, long-term surface effects can be minimized.

Reasonably Foreseeable Development Scenario (Oil & Gas)

The BLM's "reasonably foreseeable development scenario" for oil and gas is a model, or projection, of anticipated oil and gas exploration and development (leasing, exploration, development, production, and abandonment) in a defined area for a specific time (usually 10 years). The scenario is based primarily on the subsurface geology, past development history, current activity, and anticipated future demand. Consideration is also given to other significant factors, such as economics, technology, physical limitations on access, existing or anticipated infrastructure, and transportation. The rating system outlined in BLM Fluid Minerals Handbook H-1624-1 was used to determine the oil and gas potential of the DBNF. Its four rating levels include: High, Moderate, Low, and No Potential. These are defined as:

- High: Geologic environments that are highly favorable for the occurrence of undiscovered oil and/or gas resources. This includes areas previously classified as known geologic structures (KGS); inclusion in an oil and gas play as defined by the USGS national assessment, or in the absence of a play designation by USGS, the demonstrated existence of source rock, thermal maturation, and reservoir strata possessing permeability and/or physical evidence or documentation in the literature.
- Moderate: Geophysical or geological indications are favorable for the occurrence of undiscovered oil and/or gas resources. Evidence exists that one of the following may be absent: source rock, thermal maturation, and reservoir strata possessing permeability and/or porosity and traps. Geologic indication is defined by geological inference based on indirect evidence.
- Low: The geologic, geochemical, and geophysical characteristics do not indicate a favorable environment for the accumulation of oil and/or gas resources. Specific indications that one or more of the following may not be present: source rock, thermal maturation, or reservoir strata possessing permeability and/or porosity, and traps.
- No Potential: Demonstrated absence of source rock, thermal maturation, or reservoir rock that precludes the occurrence of oil and/or gas. Demonstrated absence is defined by physical evidence or documentation in the literature.

Oil and gas potentials vary across the Forest. The Redbird Ranger District has High potential while the Stearns Ranger District rates Moderate potential. The remainder of the Forest is rated at Low potential.

In the next 10 years, the RFD predicts that four wells will be drilled on the Forest to recover federally owned minerals while 12 wells are likely to be drilled for private minerals. These developments are most likely to occur on the Stearns or Redbird ranger districts. Table 3 - 16 shows the recent development trend for oil and gas on the DBNF. Approximately 80 percent of the wells drilled on the Redbird and Stearns districts will likely be natural gas producers. Approximately 13

percent will be dry holes and approximately, while 7 percent will be produce oil will yield a mixture of oil and natural gas.

Table 3 - 16. Wells Drilled on DBNF land from 1985-Present

COUNTY	Number of Wells	Gas	Dry	Oil	Oil/Gas
Clay (Redbird RD)	100	92	2	2	4
Jackson (London RD)	5	4	1	0	0
Lee (Stanton RD)	1	0	0	1	0
Leslie (Redbird RD)	34	15	7	2	10
McCreary (Stearns RD)	14	12	2	0	0
Menifee (Stanton/Morehead RD)	2	0	2	0	0
Owsley (Redbird RD)	6	4	2	0	0
Perry (Redbird RD)	0	0	0	0	0
Powell (Stanton RD)	1	1	0	0	0
Whitley (Stearns RD)	16	14	2	0	0
Total	179	142	18	5	14

This Reasonably Foreseeable Development Scenario describes the geology and the potential for petroleum occurrence on the DBNF in eastern Kentucky. It also projects the amounts of activity that could occur during the planning period (10 to 15 years).

The DBNF has had a long history of minerals activity. As of January 1, 2003, there were three active coal leases and three actions pending (one lease modification and two new lease requests). Oil and gas leases were being developed on the Forest as well.

Typical Drilling Scenario and Well Design

To fully evaluate the impacts associated with hydrocarbon exploration and development, the various activities typical of these actions should be identified and analyzed.

Well site preparation includes construction of a drilling pad as well as a reserve pit to capture drilling by-product. A typical site layout for an oil well drilled as deep as 6,000 feet can cover one to two acres. In eastern Kentucky, wells typically are drilled for less than 6,000 feet and well sites usually cover only one-half to one acre. The site is cleared and graded for construction of the well pad and reserve pit. Depending on the topography of the well site and access area, this construction may require the creation of cut slopes and fill areas. The reserve pit is usually excavated to a depth of about five feet and is lined with a plastic or butyl liner (or its equivalent) that meets state standards for thickness and quality. Constructed access roads normally have a running surface (width) of approximately 15 feet and a right-of-way of 30 feet. The length depends on the well-site location in relation to existing roads or highways. The anticipated length of road construction is about a half mile or less.

Because the cost of drilling rig time is usually several thousand dollars a day, drilling is conducted around the clock when possible. Wells are usually drilled and tested in approximately 30 days. However, the actual time will depend on the depth of the hole, the number and degree of mechanical problems, whether a hole is dry or a producer, and other related factors.

Natural gas in eastern Kentucky is dry, making air drilling is the most effective method. Wells are usually drilled by rotary drilling rig employing an air-mist as the circulating medium. Air compressors force air down the drill pipe to propel rock cuttings out of the well bore.

Two or more diesel engines provide power for the rig and air compressors. Water is required to control dust created when the compressed air returning from the well bore blows rock cuttings into the reserve pit. This water is normally trucked to the site. However, water could be pumped to the site from a local pond, stream, or lake through pipe laid on the surface.

If water is encountered during drilling, an unlikely prospect, drilling can resume using drilling mud. Approximately 800 barrels of drilling mud will be kept on the location. Mud will also be needed for some data logging programs.

Because the natural gas in the area is dry, very little water is associated with its production. Any separation, dehydration, or other necessary processing will likely be conducted off the project.

If material used in construction of the well pad or access road (i.e., rock, shale, or gravel fill) is obtained on or near the site, it must be obtained from pre-approved sources. Shale and/or gravel used in construction of the drilling pad must be stockpiled when restoring the area. For all surface-disturbing activities, the topsoil to be removed will be stockpiled for redistribution over the disturbed area prior to fertilizing and re-seeding of the site. In areas where excavation will be extensive or extreme, or where bedrock will be encountered, existing topsoil must be replaced. Restoration of the area will include reseeding with natural grasses as determined by the local Forest Service specialist. If drilling results in a producing well, the drilling pad must be reduced to a maximum area of 2,500 square feet and the remainder restored to blend into the natural terrain.

Whenever possible, pipelines and/or flow lines will be constructed in conjunction with the construction of access roads to minimize disturbance. Pipeline rights-of-way shall not exceed 25 feet in width. DBNF personnel may set exact right-of-way widths. Pipeline depth must be at least 48 inches. When possible, a common point of collection shall be established to minimize the number of production sites. All pipeline designs, construction, operation, and maintenance must comply with Federal Safety Standard for Gas Lines (49 CFR 192) unless more stringent requirements are required by the state of Kentucky.

Oil and Gas Plays on the Daniel Boone National Forest

Oil and gas has been developed for decades on the DBNF, beginning in the late 1800s. Despite this long history of development, many oil and gas plays remain. Oil and gas plays can be found in the following six geologic production zones that occur on the DBNF. Most production occurs on the Stearns and Redbird Ranger Districts.

- Upper Mississippian Mauch Chunk Group
- Upper Mississippian Greenbriar/Newman Limestones
- Lower Mississippian Weir Sandstones
- Upper Devonian Black Shales
- Lower Devonian/Upper Silurian Unconformity Play
- Cambrian-Ordovician Knox Group

Table 3 - 17. Age in geologic time of the oil and gas plays on the DBNF.

ERA	SYSTEM AND SERIES		MYPB
Cenozoic	Quaternary	Holocene	0.01
		Pleistocene	1.8
	Tertiary	Pliocene	5
		Miocene	23
		Oligocene	34
		Eocene	57
		Paleocene	65
Mesozoic	Cretaceous		144
	Jurassic		208
	Triassic		245
Paleozoic	Permian		286
	Carboniferous Systems	Pennsylvanian	320
		Mississippian	360
	Devonian		408
	Silurian		438
	Ordovician		505
	Cambrian		544

MYBP = million years before the present.

Upper Mississippian Mauch Chunk Group

This group extends from Pennsylvania, West Virginia, and Virginia into Kentucky. A conservative estimate for the cumulative production from the Mauch Chunk reservoirs is 336 bcf (billion cubic feet), based on 4,200 wells with an average production of 80 MMcf from each well. In Kentucky, the earliest gas production appears to have been in Martin County from the Pennington formation in 1899. Since that time, gas has been produced from 68 fields in 16 counties (Barlow 1996). Production from this zone is mainly in extreme eastern Kentucky including Breathitt, Floyd, Martin, and Pike counties. However, some production has extended into the southern end to the DBNF, including Whitley and Leslie counties.

Upper Mississippian Greenbriar/Newman Limestones

The Upper Mississippian Greenbriar/Newman Limestones extend from parts of southeastern Ohio to West Virginia, Virginia, and Tennessee and into eastern Kentucky. Approximately 3,400 wells produce from the Newman Limestone in 257 fields in eastern Kentucky. Production areas near the DBNF occur in Clay, Leslie, Whitley, Jackson and Owsley counties. Newman Limestone produces natural gas from two zones. These “pay” zones are confined to long and narrow tidal, fluvial, or estuarine channels running in mostly north-south direction. This production area is commonly known as the “Big Lime.”

Lower Mississippian Weir Sandstones

The Weir Sandstones production area of West Virginia, southwestern Virginia and eastern Kentucky consists of several major oil and gas plays, especially in extreme eastern Kentucky. Areas of the DBNF with potential for Weir Sandstone development (based on past trends) can be found in Clay, Laurel, Leslie, and Whitley counties. This sandstone occurs in the Lower Mississippian formations of eastern Kentucky, but several production intervals have created producing wells. These intervals are known as the Stray Gas sandstone, 1st Weir, and 2nd Weir. There has been mixed production from this zone with development of both oil and gas.

Upper Devonian Black Shales

The Upper Devonian Black Shale production occurs in eastern Kentucky, West Virginia, and Ohio. The heaviest gas production in Kentucky occurs in Knott, Floyd, and Pike counties. Portions that extend into the DBNF occur primarily in the Redbird Ranger District. Natural gas was discovered from in this zone in the late 1800s, and by 1935, it was known as one of the largest gas plays in the United States. This production zone is associated with the rock sequence from the bottom of the Berea Sandstone to the top of the Onandaga Limestone. The Big Sandy gas field (located in eastern Kentucky, just east of Leslie County), part of the Upper Devonian field, has been the major contributor to production from this zone. Cumulative gas production for the Devonian Black shale's has been approximately 3 trillion cubic feet (tcfg) from roughly 10,000 wells (Boswell 1986). Of this production, 2.5 tcfg was likely produced from the Big Sandy field (Roen and Walker 1996).

Lower Devonian/Upper Silurian Unconformity Play

The Lower Devonian/Upper Silurian Unconformity Play, located in eastern Kentucky, has a grouping of natural gas plays that have been developed on the DBNF in Clay County. Earliest discoveries were found in Morgan and Menifee counties in 1902 and 1904 respectively. Some depleted plays in this field were being used as gas storage fields by the 1970s and 1980s. Cumulative past production is estimated at between 80 to 110 bcfg. The Silurian Salina and the Lockport Dolomite are two major producing formations of this zone.

Cambrian-Ordovician Knox Group

The Cambrian-Ordovician Knox Group is located in western New York, Pennsylvania, central Ohio, eastern Kentucky, and northern Tennessee. The majority of oil and gas plays in Kentucky are found in Clay and Clinton counties. The earliest Kentucky discovery in this zone occurred in Clinton County in 1941. Production in the Clay County area began in the 1950s. Development outside the two larger fields has taken place in the Big Sinking area of Lee County. Production from the Cambrian-Ordovician Knox Group has decreased and in some cases has been entirely depleted. The Knox Unconformity Play produces for this group. The stratigraphy of this play is listed below in descending order:

- The Beekamtown Dolomite
- The Rose Run Sandstone
- The Upper sandy member of the Gatesburg Formation
- The Theresa Formation
- The Copper Ridge Dolomite
- The Sandstones in the upper Copper Ridge Dolomite
- The Krysik Sandstone
- The Lower Copper Ridge Dolomite

An area on the Stanton Ranger District has a history of oil production through secondary recovery. The market could still encourage development on the district if demand grows sufficiently. This area has been inactive for the last 5 to 10 years.

EXISTING LEASES (COAL, OIL, GAS)

There is one lease in McCreary County covering 470.79 acres, 36 leases in Clay County, covering 16,411.6 acres and 20 producing wells, six leases in Whitley County covering 11,718.97 acres and 8 producing wells, 17 leases in Leslie County covering 30,386.88 acres and 14 producing wells, and 5 leases in Owsley County covering 437.29 acres.

Minerals across the Forest have been available for leasing, but the No Surface Occupancy (NSO) stipulation has often been applied to development activities. Operators who drill wells to recover private minerals and also want to recover federally owned minerals with their producing units must join with the federal government and its lessee in a Communitization Agreement.

Coal mining may not be heavily impacted by NSO stipulations as the most recent trend is for mines to approach federal land underground from privately owned portals. However, oil and gas leasing is likely to be affected by NSO stipulations, which may limit development or discovery of oil and gas fields. Figure 3 - 11 shows tracts currently under lease or have leasing proposals under consideration. The figure also shows that most mineral development activity on the Forest is taking place on the Redbird District while the southern half of the Forest has more mineral development underway than the northern portion.

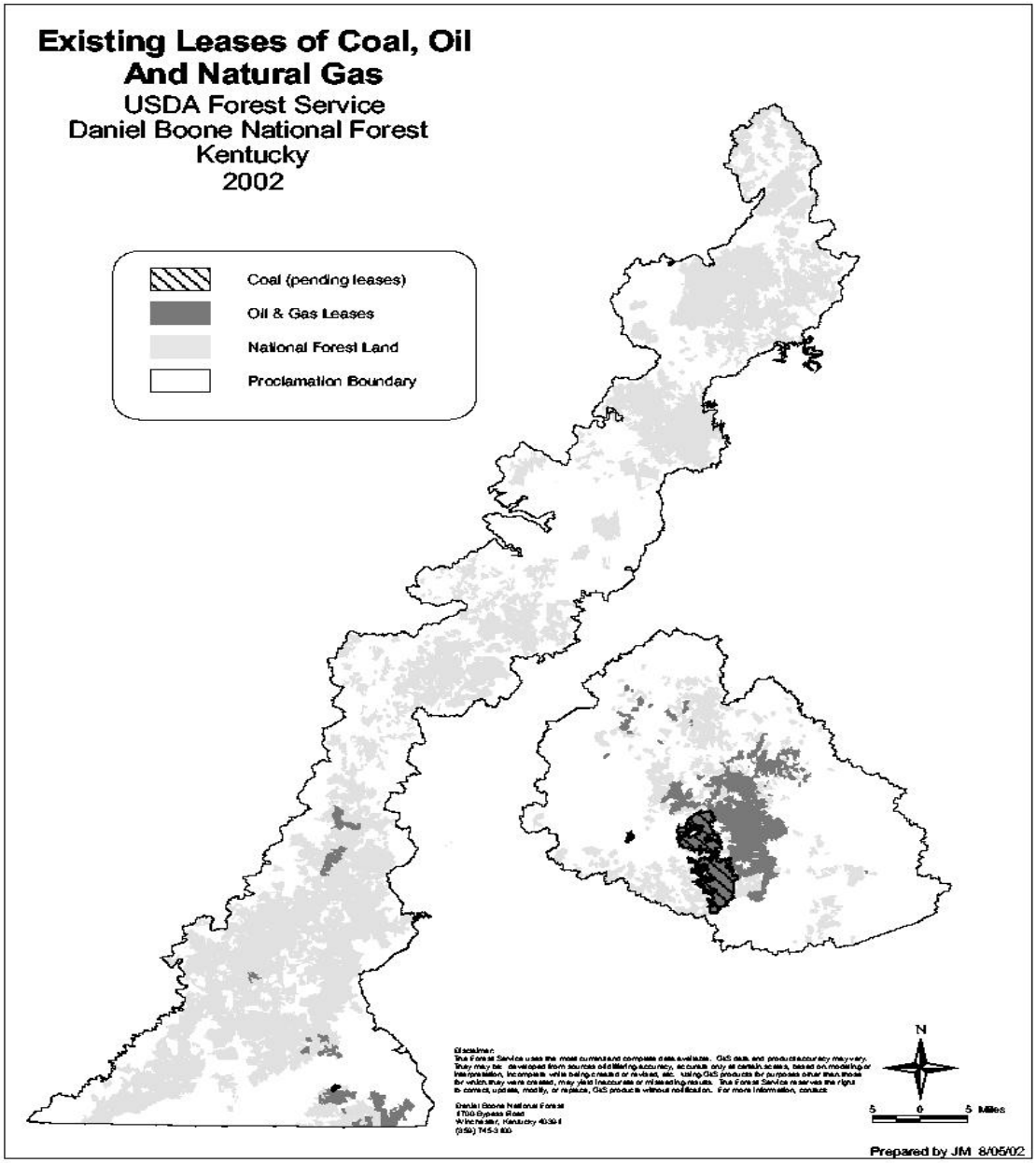

Figure 3 - 11. Existing Leases of Coal, Oil and Natural Gas on the DBNF.

Past Mineral Production and Revenues

Leasing on the DBNF has fluctuated widely over the last 10 years for a number of reasons. Figure 3 - 12 to Figure 3 - 14 illustrate the decrease in royalties generated by coal and oil resources on the Forest since 1995. The Forest has seen a slight increase in royalties from natural gas during the same period, however. A dramatic increase in these numbers has been forecast, especially for coal royalties, because of pending lease applications.

For some time, the market for oil has not been favorable for the kind of wells typically drilled on the DBNF. Most are "stripper" wells that produce marginal flows and operate on the lower edge of profitability. Many of the oil wells in production approximately 20 years ago were secondary "recovery" wells. Recovery operations inject water underground to help move oil toward production wells. Oil is unlikely to be a major component in the DBNF minerals program unless two variables change:

- Market conditions improve significantly making stripper wells more profitable.
- Conditions in the international arena create a climate in which domestic production is emphasized.

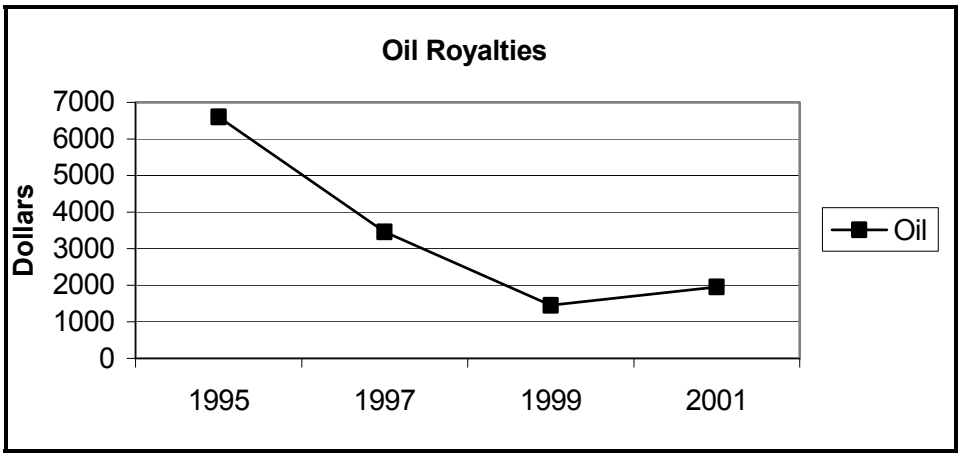

Figure 3 - 12. DBNF Oil Royalties

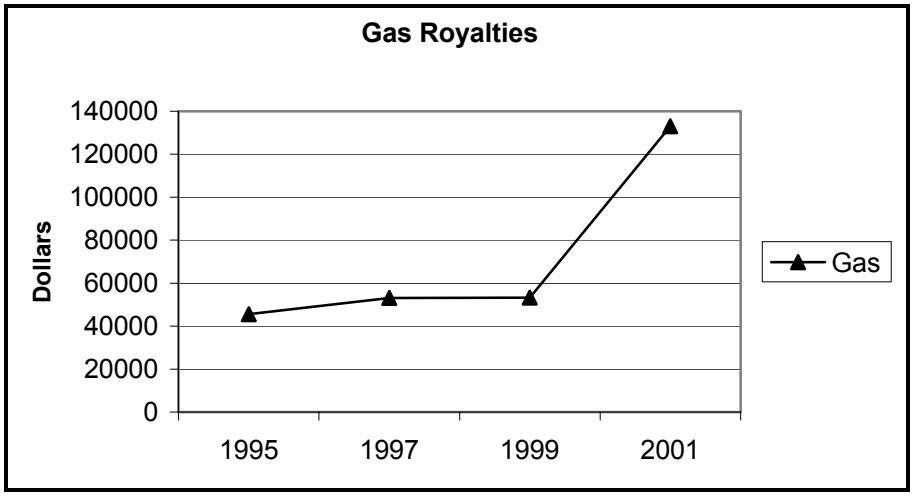

Figure 3 - 13. DBNF Gas Royalties.

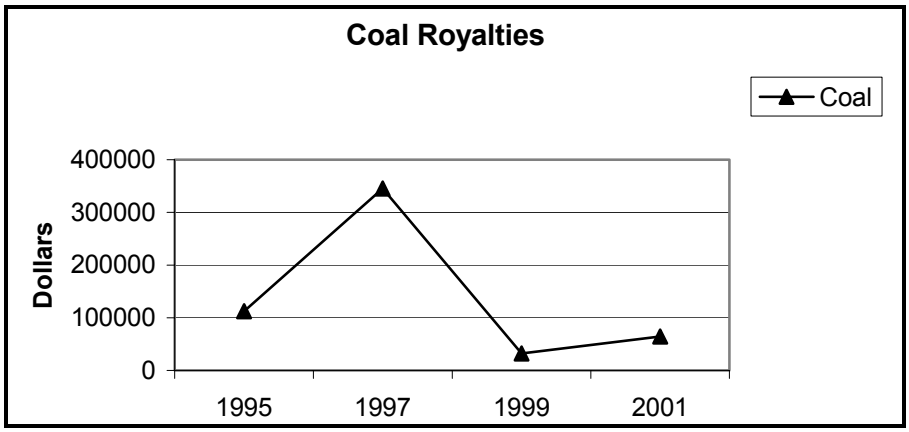

Figure 3 - 14. DBNF Coal Royalties.

Oil and Gas Production

Natural gas has been produced on most all DBNF ranger districts. Within the last 15 years, however, the bulk of development has occurred on the Stearns and Redbird Ranger Districts, mostly on private mineral rights. The development scenario during the planning period (10 to 15 years) should remain steady as it has for some time. Natural gas production in Kentucky from 1992 to 1999 remained between 75 and 80 billion cubic feet annually.[3] There should be a growing interest in development of federally owned resources as new deposits are discovered.

Oil development across the Forest has declined since approval of the 1985 Forest Plan. Oil recovery on the DBNF has mainly been a by-product of natural gas production. Wells intended to produce natural gas sometimes discover paying quantities of oil. New fields or pools will have to be discovered for interest in oil to increase. However, market conditions could create opportunities for further development of oil producing pools found on the Stanton and London Districts.

Coal Production

The Redbird district has seen the most coal development in the last 10 years. Pockets of coal of suitable thickness for underground mining are still found on this district. The Redbird district could contribute heavily to an increase in mineral royalties.

The Stearns and Somerset districts lie on the westernmost extent of the eastern Kentucky coalfield, and the bulk of coal in this area was depleted some 40 years ago. The Stearns district still has some activity, however. Mines on the Stearns and Somerset districts have often encountered problems with acid drainage. Coal seams in these districts tend to be less consistent in extent than those on the Redbird area.

Coal revenues have decreased over the period surveyed in Figure 3 - 14. Many of the mines leased since 1985 have completed operations. Several factors could change coal royalties during the next planning period:

- In the year 2000, the Tennessee Valley Authority transferred 40,000 acres of coal mineral rights to the DBNF.
- Two active leases were transferred along with the coal mineral rights.
- Three lease requests for coal development on the Forest are undergoing evaluation.

COAL RESOURCES

The DBNF covers only a small portion of the eastern Kentucky coalfield, but coal resources are present in all six ranger districts. Coal recoverable for commercial purposes is found mostly on the Redbird and Stearns ranger districts, and both have high coal potential.

The Redbird Ranger District had an estimated 201 million tons of federally owned coal resources remaining in 2002. Whitley and McCreary counties, located on the southern portion of the Forest and mostly on the Stearns Ranger District, contain approximately 57 million tons of remaining

[3] Cole, L., E. Siegel, and L.W. Lyle. 2001. 2000 - 2001 State of Kentucky's Environment. Resource extraction section. Kentucky Environmental Quality Commission. Frankfort, KY. p. 135-155

federally owned coal resources. Forestwide, about 320 million tons of federally owned coal resources remain. However, the amount of coal that can be profitably mined may be much lower because only underground mining is allowed on DBNF land. Pennsylvanian coal-bearing formations are either thin or absent in the four other Ranger Districts -- Morehead, Stanton, London, and Somerset -- giving them only moderate potential for development of federally owned coal.

The Eastern Kentucky Coal Field includes all or parts of 37 counties in Kentucky, covering 10,500 square miles (6.7 million acres). The 700,000 acres of federally owned land in the DBNF lies in 22 of these counties covering about 10.4 percent of the coalfield (Figure 3 - 15)[4].

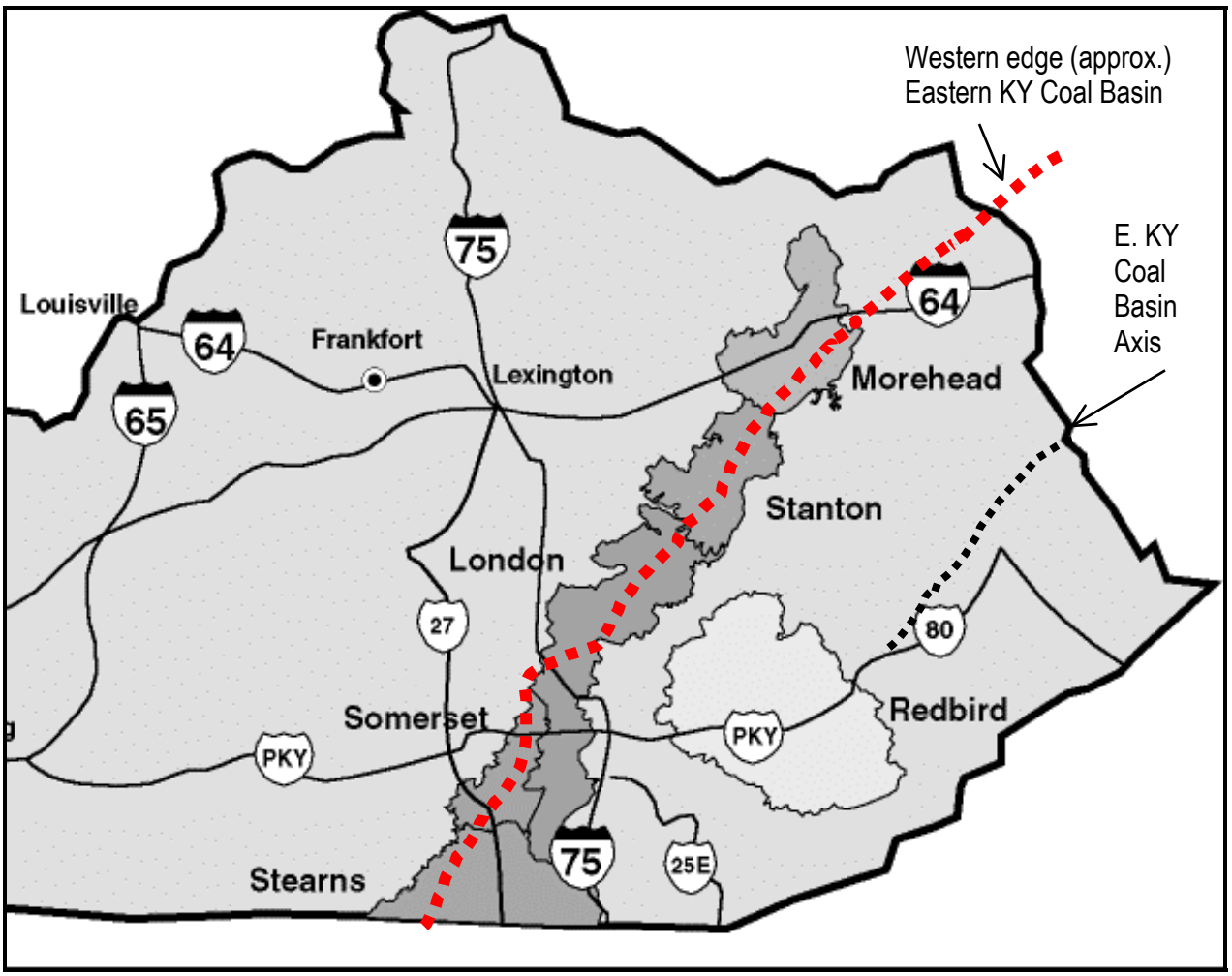

Figure 3 - 15. Interface of Eastern Kentucky Coal Basin with DBNF Ranger Districts.

Regional Geology

The DBNF lies in the eastern Kentucky portion of the Appalachian Basin in an area known as the Cumberland Plateau. The Rome Trough, containing a thick lower Paleozoic section and trending NE-SW across eastern Kentucky, significantly influenced pre-Mississippian sedimentation in eastern

[4] Eastern Kentucky Coal Field, Daniel Boone National Forest – Coal Assessment June 2002.

Kentucky. Structurally, the DBNF portion of the basin has been subject to minor local folding and faulting compared to the Valley and Ridge Province to the east. Generally flat-lying Pennsylvanian rocks are at the surface across most of the Forest. These Pennsylvanian strata consist largely of sandstone, siltstone, shale, and coal beds with some thin marine shale and limestone units. These deposits indicate that Kentucky was near sea level during the Pennsylvanian age, alternately covered by lakes, extensive swamps, shallow bays, and estuaries. Piedmont, alluvial, and coastal plain environments extended across the state at times during the Pennsylvanian period resulting in depositions of strata that today form the Eastern Kentucky Coal Field. The western edge of the Eastern Kentucky Coal Basin (Figure 3 - 15) is located along a NE-SW trend that cuts across all of the DBNF Ranger Districts except Redbird. This western boundary is a topographic feature known as the Pottsville Escarpment. It is the eroded edge of resistant Pennsylvanian-age sandstones and conglomerates on outcrop where they overlie the Mississippian rocks in eastern Kentucky.

Local Geology - Coal

The Pennsylvanian Breathitt Group, which lies at the surface, is the coal-bearing unit in eastern Kentucky. Figure 3 - 16 is a stratigraphic column of eastern Kentucky. The subsurface presence of several of the top coal-producing formations, the Hyden, Four Corners, and Princess Formations on the Redbird District gives it by far the most coal potential of any DBNF ranger district. The remaining DBNF districts have the Pikeville, Grundy, Bee Rock Sandstone, Alvy Creek, and Sewanee Sandstone Formations in the subsurface or on outcrop. With the exception of the Redbird District, three out of four of the main coal-producing horizons (Princess, Four Corners, and Hyden Formations) are not present on 79 percent (552,614 acres) of the DBNF.

The westernmost surface exposure of the Pennsylvanian Breathitt Group (Pottsville Escarpment) defines the limits of the Eastern Kentucky Coal Field. The coal-bearing formations thin to the northwest toward this outcrop. Pennsylvanian formations dip basinward (east) at about 40 feet per mile. As mentioned above, most of the DBNF lies outside the coalfield to the west of this escarpment (Figure 3 - 15).

In the northern part of the Forest, the western limit of the Breathitt Group is located near the eastern boundary of the Morehead and Stanton districts. Therefore, little coal production should be expected in those areas.

In the central part of the Forest, the western limit of the Breathitt Group outcrop is located near the boundary of the London and Somerset districts with the Somerset lying mostly west of the Breathitt Group outcrop. Consequently, little coal production should be expected on the Somerset District. The southern part of the London District does have coal potential, however.

The Breathitt Group is found on the Stearns Ranger District in the southern Forest giving it coal potential. The outcrop limit is located near the western boundary of the District and Forest. Across the entire Redbird District the Pennsylvanian Breathitt Group is at the surface. This district, therefore, has all the principal coal bearing formations on outcrop or in the subsurface. The Pennsylvanian coal bearing Breathitt Group outcrop patterns have the same NE-SW trend as the DBNF Districts (Figure 3 - 15). The axis of the Eastern Kentucky Coal Basin lies near the eastern boundary of the Redbird District.

The Fire Clay coal seam, historically the second largest producer in eastern Kentucky, occurs only on the Redbird District. The area of potential coal recovery from beneath the forest surface is further

limited by the ban of surface mining that applies to the DBNF. Current mining practices relative to the number of feet on overburden and proximity of underground works to the surface, further reduce the likelihood of mining in areas where the Pennsylvanian Breathitt Group is of limited thickness.

Western Europe State	Mid-continent USA	North American Series	Eastern Kentucky Group	Eastern Kentucky Formation	Major Coal Beds and Coal Zones *Major Marine Zones*
Westphalian D	Desmoinesian	Middle Pennsylvanian	Breathitt	Princess	Princess No. 9 Princess No. 8 Princess No. 7 Princess No. 6 Princess No. 5a, 5b Princess No. 5, Richardson, Skyline
Bolsovian	Atokan			Four Corners	*Stoney Fork Member* Broas Peach Orchard Arnen Member Hazard Haddix
Duckmantian				Hyden	*Magoffin Member* Taylor Hamlin *Fire Clay rider* Fire Clay Whitesburg
				Pikeville	*Kendrick Shale Member* Amburgy Elkins Fork Shale Upper Elkhorn No. 3 Alma *Crummies Member* Lower Elkhorn Little Eagle
Langsettian	Morrowan	Lower		Grundy	*Betsie Shale Member* Clintwood Millard *Unnamed marine zone* Hagy Splash Dam / Barren Fork Elswick / Stearns

Figure 3 - 16. Pennsylvanian Stratigraphy of Eastern Kentucky.

(Source: Kentucky Geological Survey, Map and Chart Series XII 2000)
Bureau of Land Management, Jackson Field Office, May 2002

Ranger District Summaries North to South

The **Morehead Ranger District** has 119,027 surface acres in parts of Bath, Menifee, Morgan, and Rowan counties of the Licking River Coal District in eastern Kentucky. The Pennsylvanian Formation is less than 400 feet thick. The Alvy Creek and Grundy Formations are at the surface. There is no potential for Fire Clay or Fire Clay Rider coal here because this district lies west of where these seams' can be developed. There is no Upper Elkhorn or Lower Elkhorn coal in this district.

The **Stanton Ranger District** has 62,425 surface acres in parts of Estill, Lee, Menifee, Powell, and Wolfe counties in the Southwestern and Liking River Coal Districts of eastern Kentucky. The Pennsylvanian is less than 400 feet thick. The Alvy Creek and Grundy Formations are at the surface. There is no potential for Fire Clay or Fire Clay Rider coal because this district lies west of where these seams can be developed. There is no Upper Elkhorn or Lower Elkhorn coal in this district.

The **London Ranger District** has 178,566 surface acres in parts of Estill, Jackson, Laurel, Lee, Owsley, Pulaski, Rockcastle, and Whitley counties in the Southwestern Coal District of Eastern Kentucky. The Grundy and Pikeville Formations are at the surface. There is no potential for Fire Clay or Fire Clay Rider coal because this district is west of where these seams can be developed. There is no Upper Elkhorn or Lower Elkhorn coal in this district.

The **Somerset Ranger District** has 78,380 acres in parts of McCreary and Pulaski counties in the Southwestern Coal District of eastern Kentucky. The Grundy and Pikeville Formations are at the surface. There is no potential for Fire Clay or Fire Clay Rider coal because this district lies west of where these seams can be developed. There is no Upper Elkhorn or Lower Elkhorn coal in this district.

The **Stearns Ranger District** has 114,216 surface acres in parts of McCreary, Wayne, and Whitley counties in the Southwestern Coal District of eastern Kentucky. In the Stearns District, the Pennsylvanian is 400 to 850 feet thick, according to data on regional cross-sections (Chestnut 1992). There is no potential for Fire Clay or Fire Clay Rider coal because this district lies west of where these seams can be developed. The Grundy and Pikeville Formations are at the surface. There is no Upper Elkhorn (No. 3A) except for a seam less than 14 inches thick along the southern portion of the Whitley-McCreary County line. The Lower Elkhorn seam is less than 42 inches thick along the southern portion of Whitley-McCreary county line. There is no Lower Elkhorn elsewhere in this district.

The **Redbird Ranger District** has 145,288 surface acres in parts of Clay, Harlan, Knox, Leslie, Owsley, and Perry counties in the Southwestern and Hazard Coal Districts of eastern Kentucky. This district has the most favorable geology for coal production of any on the Forest. Major coal beds in the Eastern Kentucky Coal Field are typically the thickest and most continuous in the southeast portion of the state toward Pine Mountain and thinner to the northwest (Cobb and Chestnut 1989). Along the western edge of Redbird District, the Pennsylvanian formation is 350 to 750 feet thick, according to data on regional cross-sections (Chestnut 2002). It dramatically thickens across the Redbird District to the east into eastern Leslie County where it is in excess of 3,000 feet thick near the axis of the Eastern Kentucky Coal Basin. Prolific coal-bearing formations of the Breathitt Group (Princess, Four Corners, Hyden, and Pikeville) are well developed on the Redbird District. The Fire Clay seam of the Hyden Formation is historically one of the better producers of coal in eastern Kentucky. The district has potential for coal from the Fire Clay (Hazard # 4) and Fire Clay Rider

coals. The Hyden, Four Corners, and Princess Formations are at the surface. The Upper Elkhorn (No. 3A) is 14 to 28 inches along Clay-Leslie county line and the Lower Elkhorn is 0 to 14 inches elsewhere.

Drilling for coal bed methane (CBM) occurred in 1998-2000 on the Redbird District (Beverly Quadrangle) in southeastern Clay County along the Bell-Clay County line. Objectives are coals in the Pikeville and Hyden Formations of the Pennsylvanian Breathitt Group at depths from 350 feet to 1,600 feet. Wells have initial potentials from 20 to 100 MCFGPD and are sporadically produced at the present time by NAMI Resources. Wells are too widely spaced and have an insufficient gathering system to compete with gas line pressures of deeper conventional gas wells. The lack of more CBM wells as well as line pressure problems has slowed the progress of CBM development.

With the reported average gas contents of 52-90 cubic feet/ton (Kelafant and Boyer 1988), the potential in this area for undiscovered, recoverable CBM is probably limited but still exists (Lyons 1996).

Coal Deposits

Past mining in the Eastern Kentucky Coal Field has concentrated on areas where coal is most accessible, resulting in the depletion of easily recovered resources. Deeper, harder-to-recover coal deposits will become increasingly important in the future. Furthermore, research indicates that methane gas contained in deep coal resources in the Eastern Kentucky Coal Field may also be recoverable (Kentucky Geological Survey 2002a). Some initial coal-bed methane (CBM) drilling has occurred in the Redbird Ranger District in Bell and Clay counties. CBM wells in Clay County have total depths of 1,100 to 1,300 feet and are reported in the Lower Elkhorn Coal. This Clay County producing coal is approximately 1,400 feet deeper stratigraphically than the Hazard #8 and in a below drainage position. Tests of CBM wells in this immediate area indicate rates of 15 to 100 thousand cubic feet of gas per day (MCFGPD). The depth of coals is an important consideration for CBM potential. Shallow coals (less than 300 feet) tend to have very low CBM content because much of the methane has leaked to the atmosphere. Furthermore, gas contents of coals in above-drainage mines are predicted to be very low (Lyons 1996). In 1957, two wells in the Carter Coordinate section KY 9-E-74, Harlan County, were completed in unknown coals with initial open flows of 75 and 80 MCFGPD.

Coal Production History

Coal has been produced in eastern Kentucky since 1800 when production of 100 tons was reported. Since then, the Eastern Kentucky Coal Field has produced more than 5.5 billion tons of coal. Coal is currently mined in approximately 45 different seams in eastern Kentucky.

Figure 3 - 17. Cumulative Eastern Kentucky Coalfield production in billions of tons.

Source	Tons produced
Underground	3.73
Surface	1.55
Undetermined	0.29
Total	5.57

In the year 2000, approximately 57.5 percent of eastern Kentucky's coal production came from underground mines. Nineteen counties in eastern Kentucky produced coal in the year 2000 (Kentucky Coal Production 2002).

Status Record Data – Coal Leases

As of July 31, 2002, there were four coal leases on the DBNF with four applications pending. Mineral ownership figures are based on Forest Service records.

Mills and/or Plants

The existing coal leases operate their own coal processing plants. Typically, continuous miners develop mains and submains to facilitate panel development. One continuous mining unit is used as the means of extraction and delivery to the conveyor belt but a second unit can be added should economic conditions allow. When coal is mined, the raw product consists of coal and rock; rock is collected from small partings in coal that cannot be avoided during the mining process. After coal is delivered to a stockpile outside an underground mine, it is trucked to a preparation plant where it is washed, cleaned, and concentrated to eliminate the rock, including pyrite (a primary source of sulfur in coal). Processed coal is then transported to a train loadout (Kentucky Geological Survey 2002b).

Production and Marketing

Coal mined in Kentucky is mostly used for electricity generation, heating, and coking coal for iron and steel production. These uses have specific requirements, but generally demand a high BTU value. A low sulfur, ash, and moisture content are also desirable. Eighty-one percent of Kentucky coal is used for electricity generation. The removal of chemical constituents in coal such as sulfur, chlorine, sodium, and various air pollutants is important for some uses of coal. "Washability" is a factor for measuring how easily chemical constituents and ash content can be reduced before coal is burned (Kentucky Geological Survey 2002c).

Coal Potential and Resource Estimate

Approximately 79 percent of Kentucky's annual coal production comes from the Eastern Kentucky Coal Field. Although generally lower in sulfur content and ash yield than coal from the western Kentucky coal, eastern Kentucky coal is highly variable in thickness and quality. Many eastern Kentucky coals are composed of distinct benches of coal separated from each other by thin but widespread partings. Often these benches are of varying quality and thickness (Kentucky Geological Survey 2002d). The bulk of Kentucky's substantial remaining coal seams are only 14 to 42 inches thick. These generally occur below drainage or are of poorer quality than what is currently mined. The next generation of mining will most likely be in deeper parts of the coal basins. The Kentucky Geological Survey is conducting research to determine the resource potential of below-drainage coal in the Eastern Kentucky Coal Field (Kentucky Geological Survey 2002e).

Coal resource estimates refer to the geologic or regional occurrence of coal. The primary factors for these determinations are correlation (accurate identification of beds), coal bed extent, and thickness. Coal seams less than 14 inches thick are excluded from resource estimation.

Coal reserves on the other hand, apply to that part of the resource that is technically and economically recoverable under prevailing market conditions. Some technical considerations are the character of the roof rock, mining methods, seam thickness and variation, coal inclination, interruption of coal by channels or cut-offs, and quality of coal. Since the detailed data required for reserve estimates were not available, this environmental impact statement relies on resource estimates. These are based on the correlation of coal beds, bed extent, and thickness, and provide a general knowledge of the occurrence and trends of as many coal beds, as data were obtainable. Data from the 1981 Energy Resource Series was used and updated to the present by subtracting 1981-2001 coal production from 1981 data on the 22 counties included in the DBNF.

In 1981, 10.9 percent of the remaining resources identified in DBNF counties were estimated to be located on DBNF lands (surface) (Table 3 - 18). This number was generated from all coal resources within the listed DBNF counties. It represents an estimate of coal resources based on the percent of National Forest System land in the selected counties. This does not take into account any mineral ownership considerations but considers only undifferentiated DBNF lands (surface).

As shown in Table 3 - 18, the Forest Service owns 18.3 percent of the coal rights on the DBNF. In 1981, federal ownership extended to 328.5 tons of the 1795 million tons of coal resource on the Forest. More recent information contained in the table shows that 320 million tons of federally owned coal remained on the DBNF in 2002. Land use restrictions and practical considerations will reduce the amount of coal resources available for development, however. Restrictions include the prohibition of surface mining on the DBNF. In any case, an estimate of "actual coal resources available" is beyond the scope of this report.

The Redbird district contains the most coal resources on the DBNF. The three Redbird counties (Clay, Leslie, and Owsley) had an estimated 201.0 million tons of remaining coal resources in 2002. Whitley and McCreary counties in the Stearns district also have high coal potential. Data included in Table 3 - 18 indicates that 57 million tons of coal resources remained in these counties in 2002. These two areas on the DBNF, the Redbird District plus Whitley and McCreary counties, represent about 258 million tons, or 81 percent of the total federal coal resources on the DBNF.

Application of the Unsuitability Criteria

The Surface Mining Control and Reclamation Act of 1977 (SMCRA 1977) prohibit the mining of coal by surface methods on National Forest System lands east of the 100th meridian (located in central Texas). Therefore, all coal development on Federal coal rights on the DBNF in eastern Kentucky must employ underground methods.

The requirements for federal coal land management are outlined in 43 CFR 3400 and administered by the Bureau of Land Management. Federal coal lands that authorize surface coal mining operations must be assessed using the Unsuitability Criteria found in 43 CFR 3461. Under these criteria, when federal lands are evaluated for their suitability for a coal mining lease, if the mining is to done by the underground methods and there will be no "surface coal mining operations" upon the surface of federal lands, the lands shall not be assessed as unsuitable. A ruling published on December 17, 1999, stated, "Subsidence due to underground coal mining is not included in the definition of surface coal mining operations…" This interpretation was remanded in court, appealed and re-instated so that surface effects from subsidence are not included in the definition of "surface coal mining operations." Since federal statutes allow only underground mining on the DBNF, the unsuitability criteria is not applicable to these federal lands.

Table 3 - 18. Coal Resource Estimate.

DBNF Counties north to south	FS Acreage	Total acres/ County	Calculated % FS(SO)[1]	Total Orig. Coal[2]	Remaining ('81)[3]	Production 1981 to 2002	Undergrd	Remaining (2002)	Est % FS(SO)	Remaining (2002) FS Redbird[4]	Remain. (2002) FS McCr/Whit.	Remain. (2002) FS All
Rowan	62,509	179,200	34.9	na		0			0.3488			
Bath	19,300	178,560	10.8	na		0			0.1081			
Menifee	46,622	129,920	35.5	10.53	9.7	0		9.7	0.3589			3.48
Morgan	12,948	243,840	5.3	849.4	824.87	2.9	y	821.97	0.0531			43.65
Powell	15,528	115,200	12.7	0.76	0.72	0		0.72	0.1348			0.10
Wolfe	16,458	142,080	11.2	443.92	438.25	4.3	n	433.95	0.1158			50.25
Estill	5,598	162,560	3.4	2.5	2.49	0		2.49	0.0344			0.09
Lee	8,587	133,760	6.4	364	351	1.9	n	349.1	0.0642			22.41
Jackson	58,375	221,440	26.3	375.9	359.3	2.9	*y	356.4	0.2636			93.95
Owsley	16,280	126,720	12.8	574	565	5.1	n	559.9	0.1285	71.95		71.95
Rockcastle	14,793	202,880	7.3	144.5	135.3	1.3	*y	134	0.0729			9.77
Laurel	62,478	278,400	22.4	408	352.7	8	y	344.7	0.2244			77.35
Pulaski	37,441	423,040	8.7	153	122	3.1	y	118.9	0.0885			10.52
Wayne	642	293,760	0.22	27.3	21.6	3.3	y	18.3	0.0022			0.04
McCreary	142,122	273,280	51.3	445	347.6	6.69	y	340.91	0.5201		177.31	177.31
Whitley	45,365	281,600	15.5	975.5	853	28.93	y	824.07	0.1611		132.76	132.76
Clay	77,594	301,440	25.7	1,536.11	1,457.60	20.92	y	1,436.68	0.2574	369.80		369.80
Leslie	52,194	258,560	20.1	3554.65	3380.41	127.68	y	3252.73	0.2019	656.73		656.73
Perry	2,191	218,880	1.0	3,596.70	2,925	170.41	y	2,755	0.01			27.55
Letcher	0	216,960	0.4	3105.93	2416.36	134.74	y	2281.62	0			0.00
Harlan	803	298,880	0.27	645.97	642.7	211.48	y	431.22	0.0027			1.16
Knox	74	247,680	0.0003	1,381.90	1,280	20.81	y	1,259	0.0003			0.38
Totals	697,902	4928640		17059.46	16485.6	754.46		15731.14		1098.47	310.06	1749.23

Bureau of Land Management, Jackson Field Office, 8/19/2002

[1]% of County in FS surface ownership (from USDA Forest Service data and county areas data)

[2]In millions of short tons

[3]From Energy Resources Series, 1981 data

[4](Remaining) x % FS

DBNF Coal Resource Estimate (2002)

1749 x .183 (Fed. coal rights) = 320 million tons

Redbird: 1098 x .183 (Fed. coal rights) = 201million tons

McCreary/Whitley counties: 310 x .183

(Fed. coal rights) = 57 million tons (total of two areas = 258)

81% (258/320) of Federal coal resources are in Redbird District and McCreary/Whitley County areas

Environmental Effects

AREA OF ANALYSIS

The area with the DBNF proclamation boundary constitutes the area of analysis for the environmental effects discussion for the minerals resource. The direct and indirect effect of implementing the 2004 Forest Plan will be limited to impacts that effect National Forest System lands. The cumulative effects analysis, however, will include impacts from activities off National Forest System lands and the impact they have on the indicators listed below.

The indicators to be used for this analysis are:

- Number of National Forest System acres available for lease
- Stipulations of mineral leasing applied by alternative.

INDICATOR EXPLANATION

The special lease stipulations mentioned above and discussed below are provisions that modify standard lease rights and are attached to, and made a part of, a new lease. Special stipulations provide for greater protection of identified resources as well as mitigation of negative effects.

Lease Notice (LN)

A Lease Notice provides more detailed information concerning limitations that already exist in law, lease terms, regulations, or operational orders. An LN also addresses special items the lessee should consider when planning operations but does not impose new or additional restrictions. (Lease Notices attached to leases should not be confused with Notices to Lessees.)

Notices to Lessees (NTL)

Notices to Lessees implement regulations and operating orders and serve as instructions on specific items of importance within a specified area.

Controlled Surface Use (CSU)

Under the Controlled Surface Use stipulation, use and occupancy are allowed (unless restricted by another stipulation), but certain resource values may require special operational constraints that modify leasing rights. CSU stipulations identify standards that operators must meet to mitigate potential adverse effects to surface resources. Such stipulations permit year-round occupancy and accessibility to leased lands. Discovery and development of oil and gas resources proceed under restrictions that mitigate impacts to other resources. Compliance with CSU stipulations may require more decision-making responsibility when surface-disturbing activities are proposed.
CSU compliance could increase the cost of oil and gas activities by requiring use of expensive technology to meet mitigation requirements. The use of Controlled Surface Use stipulations meets Forest Service mineral policy direction.

Timing Limitation Stipulation (TL) (Seasonal Restriction)

A Timing Limitation Stipulation prohibits surface use at specific times to protect identified resource values. TLs do not apply to the operation and maintenance of production facilities unless the findings of analysis demonstrate a continued need for mitigation that less stringent, project-specific measures cannot accomplish.

TLs are used when necessary to restrict exploration activities on leased lands for a period longer than 60 days. TLs also provide accessibility for a portion of the year while maintaining the potential for discovery and utilization of oil and gas resources. TLs may increase exploration costs by narrowing the window available for drilling. Use of TLs must conform to the Forest Service's national mineral policy.

TLs could increase development costs if a well is not completed within time limits. Shutting a drilling operation down and leaving the equipment idle or moving the equipment to another site and then moving it back increases costs. When a drilling proposal is submitted, on-the-ground conditions may allow an exemption or require an extension of timing limitations based on seasonal conditions or habitat use.

No Surface Occupancy (NSO)

Use or occupancy of the land surface for fluid mineral exploration or development is prohibited under this stipulation to protect identified resource values. Leasing with an NSO stipulation is an alternative to declaring an area "administratively unavailable" for leasing. Even though an NSO stipulation prohibits surface occupation for exploration or development of oil and gas, these subsurface resources remain legally available if they can be accessed by other means. An NSO lease may allow development through directional drilling if lands adjacent are available for leasing with surface occupancy or are privately owned. Technology limits the distance a well's surface location can be placed from the downhole location, and in some areas, any directional drilling is technically impossible. Also, directionally drilled wells are more costly to drill and to maintain and reach the end of their economic life sooner than vertically drilled wells. While drilling and production may be more costly, leasing with NSO does offer opportunities for exploration and development of resources that would otherwise be unavailable. Leasing with No Surface Occupancy, therefore, meets Forest Service minerals policy direction.

Statutorily Withdrawn (WD)

Federal minerals are not available for leasing due to law or statute enacted by Congress**.**

RESOURCE TABLES

Figure 3 - 18. Oil/Gas Projections for the Next Two Decades.

Total Wells per Decade	Fed Leasing Decision and Well Construction		Private Minerals on the DBNF		Off-Forest Wells*	
Alt.	Decade 1	Decade 2	Decade 1	Decade 2	Decade 1	Decade 2
A	35	23	100	65	3050	3250
B-1	0	0	75	50	3050	3250
C	40	25	120	75	3050	3250
C-1	40	25	120	75	3050	3250
D	40	25	120	75	3050	3250
E	60	38	150	90	3050	3250

*Considers development in eastern Kentucky

Figure 3 - 19. Oil/Gas Projections Annually.

Annual wells	Fed Leasing Decision and Well Construction		Private Minerals on the DBNF		Off-Forest Wells*	
Alt.	Decade 1	Decade 2	Decade 1	Decade 2	Decade 1	Decade 2
A	3.5	4.6	10	6.5	305	325
B-1	0	0	7.5	5	305	325
C	4	5	12	7.5	305	325
C-1	4	5	12	7.5	305	325
D	4	5	12	7.5	305	325
E	6	7.6	15	9	305	325

*Considers development in eastern Kentucky

Work to develop wells on the Forest will primarily take place in the 1.K, 1.M, 4.A, and 4.B prescription areas on the Stearns and Redbird ranger districts. The 4.A Timber Production Prescription Area of Alternative E-1 would hold the greatest potential for mineral development. About 11 acres scattered throughout in this prescription area's 396,000 acres would likely be disturbed for this purpose. The number of acres that would potentially be disturbed by drilling operations under the various alternatives are:

Figure 3 - 20. Potential Surface Disturbance Annually.

Alt.	Acres for Federal Min.	Acres for Private Min.	Acres Off-Forest
A	4.4	22	88
B-1	0	16.5	88
C	6.6	26.4	88
C-1	6.6	26.4	88
D	6.6	26.4	88
E-1	11	33	88

The numbers for Figure 3 - 20 were generated using the assumptions that roads to access well pads on the DBNF generally will not exceed a half-mile and that one-mile of road access for well development equals about 2.4 acres of disturbance.

EFFECTS COMMON TO ALL ALTERNATIVES

DIRECT AND INDIRECT EFFECTS

Private owners are free to develop reserved and outstanding minerals on the Forest based on valid existing rights, severance deed rights, state and federal laws, the Secretary of Agriculture's Rules and Regulations (for reserved mineral rights only) and an approved plan of operations. Private mineral activity often influences federal mineral development. Private mineral developers may find trends for oil and gas fields that appear to occur among federal minerals. If so, they may choose to initiate an exploration project or pursue drilling on National Forest System lands. Deep mining of coal also influences development of federal coal as well. With the mixed ownership pattern of both surface and mineral rights on the DBNF, the development of privately owned coal may take place adjacent to federal coal.

Direct effects immediately follow a specific action or activity and occur at the same place. Leasing itself would not cause direct effects, though it is reasonable to expect direct effects to result from subsequent exploration and development. These effects on lands and resources were analyzed assuming reasonably foreseeable development activities.

Indirect effects are caused by a specific action or activity but typically occur later in time and farther in distance. Indirect effects on lands and resources were analyzed for the alternatives. Direct and indirect effects were sometimes considered together and not specifically identified or disclosed separately.

The designation of acres as available for oil and gas leasing does not cause a direct effect to those acres. That decision only authorizes the BLM to issue leases for those acres under standard lease terms and subject to additional constraints.

Prescription Area 1.C, Cliffline Community – No Surface Occupancy/ Controlled Surface Use

This Prescription Area is an area that runs from 100 feet above the cliffline to 200 feet below the cliffline. The No Surface Occupancy stipulation applies to the above-cliffline zone, while the below-cliffline zone is protected by the Controlled Surface Use stipulation.

The hydrologic condition of cliffline habitat is a key component of this ecosystem. The No Surface Occupancy stipulation is intended to prevent subsurface as well as surface disturbance. Some activities are permitted in the below-cliffline zone, but only if they pose no threat to PETS species and do not adversely impact the long-term integrity of cliffline habitat. Road construction for geophysical uses is prohibited in this prescription area.

Prescription Area 1.G, Rare Communities – No Surface Occupancy & Controlled Surface Use

Minerals management is allowed in these areas under the No Surface Occupancy stipulation in the Rare Community *Site*; in the remainder of the prescription area (the Rare Community Management *Zone*), the Controlled Surface Use stipulation protects the integrity of rare community habitat. Rare communities on the DBNF are often natural wetlands or the ecosystem associated with natural wetlands. These areas are to be noted during pre-construction field visits and avoided to protect rare community sites. A minimum 100-foot buffer from the outer edge of the wetland ecosystem is recommended. A buffer determined at the project level may also protect other rare community sites.

Prescription Area 1.I, Old-Growth – Controlled Surface Use

Old-growth communities will be protected by the Controlled Surface Use stipulation, which allows only one percent of area identified as old-growth to be disturbed for mineral leasing over the life of the Forest Plan.

For example, only three surface acres of an old-growth area 300 acres in size may be for mineral lease purposes. Should one-half acre be used for a development in the first year, only 2.5 acres would be available for disturbance afterward.

Access

Access to federal minerals within the DBNF will be affected to some degree by leasing stipulations. No Surface Occupancy relegates mineral developments to locations where they will not interfere with ecosystem management goals. However, such locations may not be advantageous for mineral development. Natural conditions as well as administrative restrictions can render mineral development unprofitable. Directional drilling has not been used on the DBNF because local conditions generally make investing in this technology unprofitable.

Availability of Mineral Resources

Coal operations (underground mining) will be largely unaffected by restrictions in any alternative. Areas unavailable for leasing, such as developed recreational areas and wilderness areas, generally are small and avoiding them should pose no problem. In any case, such areas often have little potential for coal development. Since coal will be developed only by underground methods, prescription area standards for surface resources will have little effect on coal mine development.

Oil and gas resources also remain available, but as mentioned earlier, the impact of lease stipulations on oil and gas operations are far more significant. Surface occupancy helps reduce costs and provides a wider range of access opportunities. Surface occupancy restrictions can so limit the space available for operations that development becomes unprofitable.

CUMULATIVE EFFECTS (COMMON TO ALL ALTERNATIVES)

The only cumulative effects anticipated from mineral exploration and development on the DBNF over the next 10 years would be associated with oil and gas development. The BLM's Reasonably Foreseeable Development Scenario projects that approximately four oil and/or gas wells will be drilled on the Forest annually to recovery federally owned minerals. Three of these will likely be commercially productive. Sites resulting in dry holes would be totally reclaimed. For each of the three producing well sites, the area needed for production would be less than was required for the drilling phase. There would be a residual of two disturbed acres for each new producing well, one acre for the access road and another acre for the pump jack and ancillary tanks or pipelines. (Drill pad size would decrease from one acre to about a half acre with the unneeded portion being reclaimed.) With two acres of disturbed area per new producing well created each year, 60 acres of developed land would remain from these activities over the 10-year planning period.
When looking at potential cumulative impacts to air quality, water quality (hydrology), aquatic habitat, wildlife, threatened and endangered species, soils, and visual qualities over the life of this plan, the impacts should be negligible.

The positive economic impacts resulting from oil and gas exploration and development should also be taken into account. Lessees/operators usually contract locally for road and drill pad construction. They purchase food, fuel, lodging, and other supplies from local sources and may subcontract certain parts of the operation to local well servicing companies. Most of the salaries paid to workers are spent in the local area. The estimated dollars that an average drill rig generates per day is over $200 per worker. A typical well drilling operation will have an average of 10 workers. This translates into about $2,000 per day spent in the local area. Since the average well in Kentucky takes 5-7 days to complete, $10,000 to $14,000 per well would be pumped into the local economy.

ALTERNATIVE A

DIRECT AND INDIRECT EFFECTS

Table 3 - 19. Surface Mineral Stipulations by Prescription Area for Alterative A.

PRESCRIPTION AREA	Acres[1]	Acres of Federal Minerals	Stipulation
1.A Research Natural Areas	658	0	NSO
1.C. Cliffline Community	111,205	28,312	NSO
1.E. Riparian Corridor	155,379	55,263	N/A
1.G. Rare Community (Estimate)	1,200	257	N/A
1.I. Designated Old-Growth	15,300	N/A	N/A
1.J. Significant Bat Caves	6,115	1,359	NSO
2.A. Clifty Wilderness	12,646	3,189	WD
2.B. Beaver Creek Wilderness	4,791	3,444	WD
3.A. Developed Recreation	3,700	0	NSO
3.B. Large Reservoirs	30,673	19,836	NSO
3.C. Wild & Scenic Rivers	15,173	4,837	NSO
3.E. Red River Gorge Geological Area	16,042	7,548	NSO
3.F. Natural Arch Scenic Area	1,065	608	NSO
3.H.1. Ruffed Grouse Emphasis	10,535	1,856	LN
4.B General Forest Area	568,206	201,536	LN
5.A. Communications Sites	20	0	NSO
5.C. Source Water Protection	34,015	3,511/7,208	N/A

[1]These acreage totals may overlap with other prescription areas. The oil and gas leasing stipulations apply to Federal minerals within these prescription areas.

CSU = Controlled Surface Use, LN = Lease Notice, NSO = No Surface Occupancy,

WD = Statutorily Withdrawn, N/A = Not Applicable.

Under Alternative A, approximately 85 percent of the federal minerals on the DBNF would be available for leasing. The 1985 Plan, represented by Alternative A, included a management area known as General Forest that was generally available for mineral leasing.

Under Alternative A, identification and analysis of impacts would mostly take place at the project level. Wilderness areas as well scenic areas near developed recreation areas would be protected from surface occupancy. At the Forest Plan level of analysis, this alternative would offer nominal surface occupancy restriction for mineral development, which could lead to inconsistencies in mitigating the impacts of specific projects. In the above table, areas identified as “N/A” are not applicable because

these prescription areas were not part of the 1985 Plan. There could be an increased workload at the project level to analyze projects to include many concerns that the other alternatives have addressed through the creation of prescription areas. A large number of acres would remain available for lease, but efforts to maintain species viability and protect other resources while exploring for and developing minerals would all be incorporated in project analyses. Over time, this could lead to major delays in processing lease proposals.

CUMULATIVE EFFECTS OF ALTERNATIVE A

A large number of acres would remain available for lease under this alternative. The cumulative effects of this alternative would be minimal in relation to the amount of acres available for lease or the lease stipulations applied.

ALTERNATIVE B-1

DIRECT AND INDIRECT EFFECTS

Alternative B-1, the alternative that emphasizes custodial management, would preclude surface occupancy for mineral development on most of the Forest (Table 3 - 20). Underground mining could take place under the same suitability criteria that would apply to all alternatives.

Table 3 - 20. Surface Mineral Stipulations by Prescription Area for Alterative B-1.

PRESCRIPTION AREA	Acres[1]	Acres of Federal Minerals	Stipulation
1.A Research Natural Areas	658	0	NSO
1.C. Cliffline Community	111,205	28,312	NSO
1.E. Riparian Corridor	155,379	55,263	NSO
1.G. Rare Community (Estimate)	1,200	257	NSO
1.I. Designated Old-Growth	15,300	N/A	N/A
1.J. Significant Bat Caves	6,115	1,359	NSO
1.M. Custodial Area	394,163	133,938	NSO
2.A. Clifty Wilderness	12,646	3,189	WD
2.B. Beaver Creek Wilderness	4,791	3,444	WD
2.C. Wilderness Study Area	2,834	350	NSO
3.A. Developed Recreation	3,700	0	NSO
3.B. Large Reservoirs	30,673	19,836	NSO
3.C. Wild & Scenic Rivers	15,173	4,837	NSO
3.E. Red River Gorge Geological Area	16,042	7,548	NSO
3.F. Natural Arch Scenic Area	1,065	608	NSO
3.H.1. Ruffed Grouse Emphasis	10,535	1,856	N/A
5.A. Communications Sites	20	0	NSO
5.C. Source Water Protection	34,015	10,719	NSO

[1]These acreage totals may overlap with other prescription areas. The oil and gas leasing stipulations apply to Federal minerals within these prescription areas.

CSU = Controlled Surface Use, NSO = No Surface Occupancy,

WD = Statutorily Withdrawn, N/A = Not Applicable.

To accomplish its goals, this alternative would place the No Surface Occupancy (NSO) stipulation on federal mineral development in all but two of its prescription areas. The two Wilderness Areas would be classified as Statutorily Withdrawn. Only in cases of national emergency or national security could the NSO stipulation be revisited under this alternative. Alternative B-1 would also increase costs for those seeking to develop privately owned oil and gas resources on the Forest. Directional drilling has seldom been used in this area and the unfavorable cost/benefit ratio would render its use unlikely. The development of federally owned oil and gas resources would be significantly reduced. There might be some opportunities for coal development via underground mining methods, but even minimal subsidence would not be allowed.

This alternative could also hinder the treatment of areas in need of reclamation from past mineral projects that the Forest Service has acquired for that purpose. Impacts from these unreclaimed areas would remain with no plans made to deal with them. The goal of this alternative would be to remove new human influences and let natural processes shape the Forest environment.

CUMULATIVE EFFECTS OF ALTERNATIVE B-1

This alternative would limit oil and gas development. Access to areas of interest for exploration or development of mineral resources would become more difficult even if adjacent private lands indicated some potential on the DBNF. Reduced exploration and operations might cause some, but not great, negative impact to some local economies.

ALTERNATIVE C

DIRECT AND INDIRECT EFFECTS

Alternative C would focus primarily on ecosystem management. Forest management activities would concentrate on the protection or enhancement of Forest ecosystems, especially habitat for PETS species. Multiple uses of Forest resources would occur in this context.

Table 3 - 21. Surface Mineral Stipulations by Prescription Area for Alterative C.

PRESCRIPTION AREA	Acres[1]	Acres of Federal Minerals	Stipulation
1.A Research Natural Areas	658	0	NSO
1.C. Cliffline Community	111,205	28,312	NSO/CSU[2]
1.E. Riparian Corridor	155,379	55,263	CSU
1.G. Rare Community (Estimate)	1,200	257	NSO/CSU[3]
1.I. Designated Old-Growth	15,300	N/A	CSU
1.J. Significant Bat Caves	6,115	1,359	NSO
1.K. Habitat Diversity Emphasis	386,577	124,403	LN
2.A. Clifty Wilderness	12,646	3,189	WD
2.B. Beaver Creek Wilderness	4,791	3,444	WD
3.A. Developed Recreation	3,700	0	NSO
3.B. Large Reservoirs	30,673	19,836	NSO
3.C. Wild & Scenic Rivers	15,173	4,837	NSO
3.E. Red River Gorge Geological Area	16,042	7,548	NSO
3.F. Natural Arch Scenic Area	1,065	608	NSO
3.H.1. Ruffed Grouse Emphasis	10,535	1,856	N/A
5.A. Communications Sites	20	0	NSO
5.C. Source Water Protection	34,015	3,511/7,208	NSO/CSU[4]

[1]These acreage totals may overlap with other prescription areas. The oil and gas leasing stipulations apply to Federal minerals within these prescription areas.
[2]NSO above and CSU below the cliffline
[3]NSO on RC site; CSU in remainder of RC management zone
[4]Zone 1 (NSO); Zone 2 (CSU)
CSU = Controlled Surface Use, LN = Lease Notice, NSO = No Surface Occupancy,
WD = Statutorily Withdrawn, N/A = Not Applicable

Federal minerals would be available for lease under this alternative, but many acres would be subject to stipulations designed to protect other Forest resources, especially ecosystem health and habitat for PETS species. The reduced acreage available for non-stipulated leasing for oil and gas development would limit access and increase costs that would eventually be passed on to consumers. Most areas where the No Surface Occupancy stipulation would be applied would be localized, however, and most projects could work around areas of concern but at greater cost. In the eastern portion of the Forest, such as the Redbird District, restrictions placed on riparian areas would leave fewer opportunities for mineral development. The steep slopes of many remaining areas would make erosion control difficult and increase the likelihood of sediment entering streams.

CUMULATIVE EFFECTS OF ALTERNATIVE C

There should be no cumulative effects from implementation of this alternative.

ALTERNATIVE C-1

DIRECT AND INDIRECT EFFECTS

Alternative C-1 would emphasize ecosystem management with an added focus on recreation. Many acres would be subject to stipulations to protect ecosystems and other Forest resources. The NSO or CSU stipulations would be applied where appropriate. The CSU stipulation would allow mineral development as long as its protective restrictions were met.

Table 3 - 22. Surface Mineral Stipulations by Prescription Area for Alterative C-1.

PRESCRIPTION AREA	Acres[1]	Acres of Federal Minerals	Stipulation
1.A Research Natural Areas	658	0	NSO
1.C. Cliffline Community	111,205	28,312	NSO/CSU[2]
1.E. Riparian Corridor	155,379	55,263	CSU
1.G. Rare Community (Estimate)	1,200	257	NSO/CSU[3]
1.I. Designated Old-Growth	15,300	N/A	CSU
1.J. Significant Bat Caves	6,115	1,359	NSO
1.K. Habitat Diversity Emphasis	386,577	124,403	LN
2.A. Clifty Wilderness	12,646	3,189	WD
2.B. Beaver Creek Wilderness	4,791	3,444	WD
3.A. Developed Recreation	3,700	0	NSO
3.B. Large Reservoirs	30,673	19,836	NSO
3.C. Wild & Scenic Rivers	15,173	4,837	NSO
3.E. Red River Gorge Geological Area	16,042	7,548	NSO
3.F. Natural Arch Scenic Area	1,065	608	NSO
3.H.1. Ruffed Grouse Emphasis	10,535	1,856	LN
5.A. Communications Sites	20	0	NSO
5.C. Source Water Protection	34,015	3,511/7,208	NSO/CSU[4]

[1]These acreage totals may overlap with other prescription areas. The oil and gas leasing stipulations apply to Federal minerals within these prescription areas.

[2]NSO above and CSU below the cliffline

[3]NSO on RC site; CSU in remainder of RC management zone

[4]Zone 1 (NSO); Zone 2 (CSU)

CSU = Controlled Surface Use, LN = Lease Notice, NSO = No Surface Occupancy,
WD = Statutorily Withdrawn, N/A = Not Applicable

CUMULATIVE EFFECTS OF ALTERNATIVE C-1

There should be no cumulative effects from implementation of this alternative.

ALTERNATIVE D

DIRECT AND INDIRECT EFFECTS

The recreation emphasis of Alternative D would provide opportunities for mineral leasing while mitigating impacts to surface resources. Legal constraints for protection of species and habitat would be in place and all project-level analysis would seek to meet these goals. Under this alternative management would seek to improve or provide expanded recreational opportunities for the public. In achieving this, opportunities for mineral development would likely occur, especially for oil and gas development. Surface occupancy would be available in more areas, and the creation of new access for additional recreation development would likely create new areas for mineral development also.

Table 3 - 23. Surface Mineral Stipulations by Prescription Area for Alterative D.

PRESCRIPTION AREA	Acres[1]	Acres of Federal Minerals	Stipulation
1.A Research Natural Areas	658	0	NSO
1.C. Cliffline Community	111,205	28,312	NSO/CSU[2]
1.E. Riparian Corridor	155,379	55,263	CSU
1.G. Rare Community (Estimate)	1,200	257	NSO/CSU[3]
1.I. Designated Old-Growth	15,300	N/A	CSU
1.J. Significant Bat Caves	6,115	1,359	NSO
1.K. Habitat Diversity Emphasis	386,577	124,403	LN
2.A. Clifty Wilderness	12,646	3,189	WD
2.B. Beaver Creek Wilderness	4,791	3,444	WD
3.A. Developed Recreation	3,700	0	NSO
3.B. Large Reservoirs	30,673	19,836	NSO
3.C. Wild & Scenic Rivers	15,173	4,837	NSO
3.E. Red River Gorge Geological Area	16,042	7,548	NSO
3.F. Natural Arch Scenic Area	1,065	608	NSO
3.H.1. Ruffed Grouse Emphasis	10,535	1,856	LN
5.A. Communications Sites	20	0	NSO
5.C. Source Water Protection	34,015	3,511/7,208	NSO/CSU[4]

[1]These acreage totals may overlap with other prescription areas. The oil and gas leasing stipulations apply to Federal minerals within these prescription areas.

[2]NSO above and CSU below the cliffline

[3]NSO on RC site; CSU in remainder of RC management zone

[4]Zone 1 (NSO); Zone 2 (CSU)

CSU = Controlled Surface Use, LN = Lease Notice, NSO = No Surface Occupancy,
WD = Statutorily Withdrawn, N/A = Not Applicable

CUMULATIVE EFFECTS OF ALTERNATIVE D

There should be no cumulative effects from implementation of this alternative.

ALTERNATIVE E-1

DIRECT AND INDIRECT EFFECTS

This alternative would emphasize the production of goods and services to benefit the public. The Forest would take proactive measures to make mineral leasing opportunities available to boost employment locally as well as benefit the regional as well as the national economy.

One goal of Alternative E-1 would be meeting the demand for domestic minerals production. The Forest would actively encourage industry to develop federal minerals. Following recent trends in coalmine development, local economies in the Redbird and Stearns Districts would benefit most. Opportunities for oil and gas development would increase on all four southern districts, however. Surface disturbance associated with deep mining would increase sedimentation. Although these effects would generally be felt off National Forest System lands, they are still impacts to be taken into account. Short-term impacts would be associated with well pad development. Generally, the disturbance from well pad construction is small, and vegetation is not difficult to re-establish. New access roads to facilitate development could create problems if not adequately maintained.

Table 3 - 24. Surface Mineral Stipulations by Prescription Area for Alterative E-1.

PRESCRIPTION AREA	Acres[1]	Acres of Federal Minerals	Stipulation
1.A Research Natural Areas	658	0	NSO
1.C. Cliffline Community	111,205	28,312	NSO/CSU[2]
1.E. Riparian Corridor	155,379	55,263	CSU
1.G. Rare Community (Estimate)	1,200	257	NSO/CSU[3]
1.I. Designated Old-Growth	15,300	N/A	CSU
1.J. Significant Bat Caves	6,115	1,359	NSO
1.K. Habitat Diversity Emphasis	386,577	124,403	LN
2.A. Clifty Wilderness	12,646	3,189	WD
2.B. Beaver Creek Wilderness	4,791	3,444	WD
3.A. Developed Recreation	3,700	0	NSO
3.B. Large Reservoirs	30,673	19,836	NSO
3.C. Wild & Scenic Rivers	15,173	4,837	NSO
3.E. Red River Gorge Geological Area	16,042	7,548	NSO
3.F. Natural Arch Scenic Area	1,065	608	NSO
3.H.1. Ruffed Grouse Emphasis	10,535	1,856	LN
4.A. Timber Emphasis	369,697	135,122	CSU
5.A. Communications Sites	20	0	NSO
5.C. Source Water Protection	34,015	3,511/7,208	NSO/CSU[4]

[1]These acreage totals may overlap with other prescription areas. The oil and gas leasing stipulations apply to Federal minerals within these prescription areas.
[2]NSO above and CSU below the cliffline
[3]NSO on RC site; CSU in remainder of RC management zone
[4]Zone 1 (NSO); Zone 2 (CSU)
CSU = Controlled Surface Use, LN = Lease Notice, NSO = No Surface Occupancy,
WD = Statutorily Withdrawn, N/A = Not Applicable

CUMULATIVE EFFECTS OF ALTERNATIVE E-1

There should be no cumulative effects from implementation of this alternative.